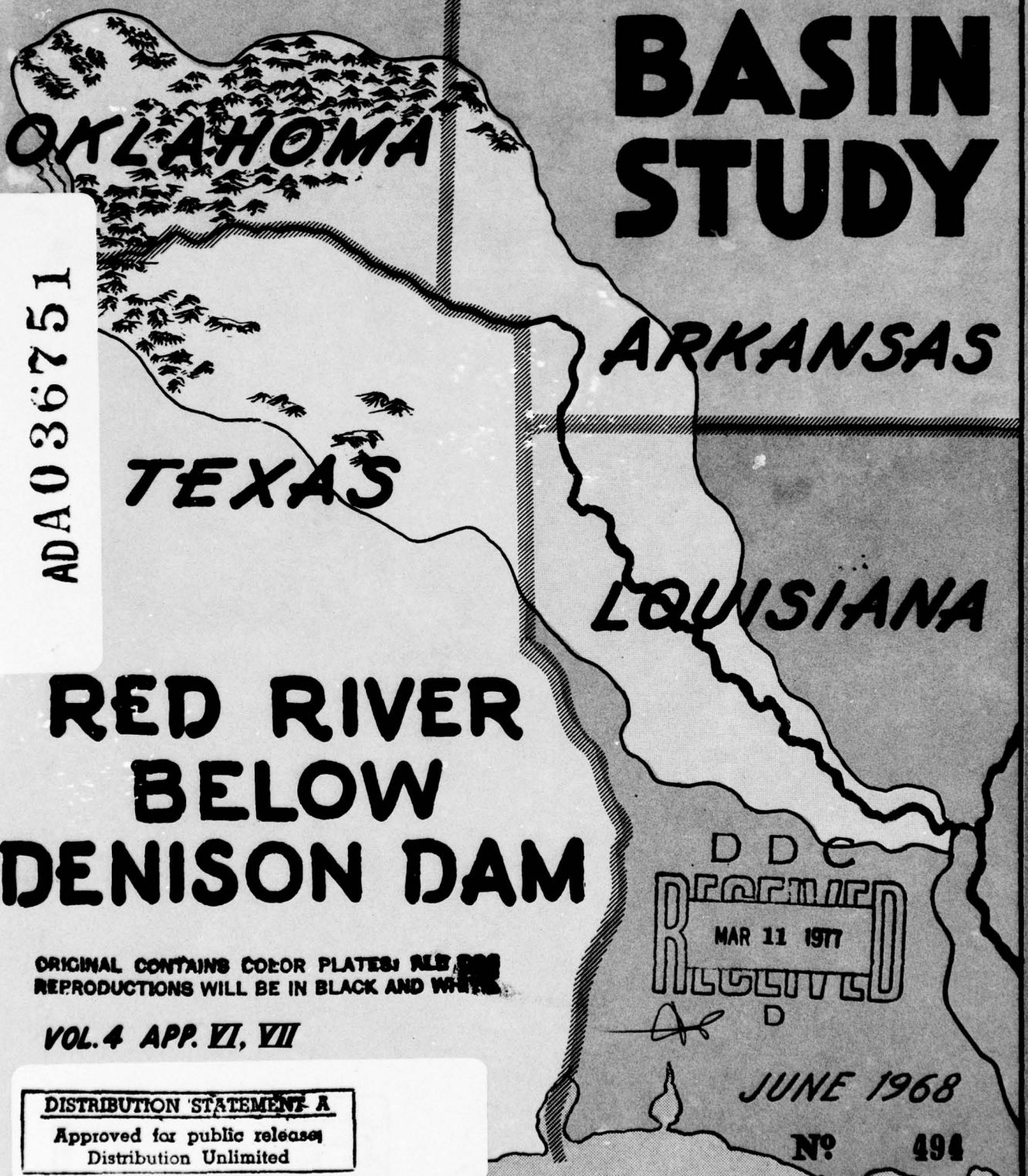
AD-A036 751 RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA F/G 8/6
COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSA--ETC(U)
JUN 68

UNCLASSIFIED NL

1 OF 3
AD
A036751

COMPREHENSIVE BASIN STUDY



RED RIVER BELOW DENISON DAM

ORIGINAL CONTAINS COLOR PLATES: ALL DTIC REPRODUCTIONS WILL BE IN BLACK AND WHITE

VOL. 4 APP. VI, VII

JUNE 1968

No. 494

RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
COMPREHENSIVE BASIN STUDY

VOLUME INDEX

Volume 1	-	Summary Report	
Volume 2	-	Appendix I	- Economics
		Appendix II	- Climate and Meteorology
		Appendix III	- Hydrology, Surface and Ground Water, and Geology
		Appendix IV	- Flood Control and Major Drainage
Volume 3	-	Appendix V	- Upstream Watershed Protection, Use, Management, and Development
Volume 4	-	Appendix VI	- Irrigation, and
		Appendix VII	- Drainage and Flood Prevention on Flatlands
Volume 5	-	Appendix VIII	- Mineral Resources and Mineral Industry
		Appendix IX	- Archeological, Historical, and Natural Resources
		Appendix X	- Hydroelectric Power
Volume 6	-	Appendix XI	- Water Supply and Water Quality Control
		Appendix XII	- Outdoor Recreation
		Appendix XIII	- Fish and Wildlife
Volume 7	-	Appendix XIV	- State Water Laws, Policies, and Programs
Volume 8	-	Appendix XV	- Plan Formulation

(6) Comprehensive Basin Study.

RED RIVER BELOW DENISON DAM, ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS, ~~COMPREHENSIVE BASIN STUDY~~

Volume 4.

Appendices VI and VII.

(11) Jun 68 (12) 260 p.

APPENDIX VI

IRRIGATION

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

Prepared by
U. S. Department of Agriculture
and
U. S. Department of the Interior, Bureau of Reclamation

June 1968

APPENDIX VI

IRRIGATION

TABLE OF CONTENTS

	Page
SUMMARY	VI-1
INTRODUCTION	VI-3
AUTHORITY	VI-3
OBJECTIVES AND NATURE OF STUDY	VI-3
DESCRIPTION OF THE STUDY AREA	VI-5
AGENCIES PARTICIPATING IN THE STUDY	VI-5
IRRIGATION PROBLEMS	VI-6
HISTORY OF INVESTIGATIONS	VI-6
NATURE AND EXTENT OF IRRIGATION PROBLEM	VI-10
General Description of Inventory Studies	VI-11
Source of Data	VI-11
Criteria for Problem Area Determination	VI-12
Soil Conservation Service Irrigation Guides	VI-12
Soil Conservation Service Questionnaires	VI-16
Bureau of Reclamation Land Classification Standards	VI-17
Area Inventory	VI-20
PRESENT IRRIGATION DEVELOPMENT	VI-24
Irrigated Crops by States	VI-24
Irrigation Water Sources	VI-26
Irrigation Facilities	VI-26
WATER LAWS BY STATES	VI-27
WATER QUALITY	VI-27
UNIT WATER REQUIREMENTS	VI-28
POTENTIAL IRRIGATION DEVELOPMENT	VI-30
WATER AVAILABILITY	VI-30
ECONOMIC FACTORS	VI-33
FUTURE NEEDS FOR IRRIGATION DEVELOPMENT	VI-36

TABLE OF CONTENTS (cont'd)

	Page
APPRAISAL OF POTENTIAL DEVELOPMENT	VI-36
Project-Type	VI-39
Individual Development	VI-40
WATER RESOURCES FOR POTENTIAL DEVELOPMENT	VI-40
WATER QUANTITY AND QUALITY REQUIREMENTS	VI-40
WATER SUPPLY COSTS	VI-43
ADEQUACY OF WATER SUPPLY	VI-45

TABLES

No.	Title	Page
1	LAND CLASSIFICATION SPECIFICATIONS FOR GRAVITY IRRIGATION	VI-21
2	IRRIGATED AND SIMILAR LAND	VI-23
3	IRRIGATED CROPLAND HARVESTED: ACREAGE, BY STATES	VI-24
4	IRRIGATED ACREAGE BY CROPS	VI-25
5	SOURCES OF WATER USED FOR IRRIGATION	VI-26
6	INVENTORY OF IRRIGATION FACILITIES BY STATES	VI-27
7	IRRIGATION WATER REQUIREMENTS - 90 PERCENT CHANCE	VI-28
8	UNIT WATER REQUIREMENTS	VI-29
9	MONTHLY RED RIVER FLOWS	VI-30
10	JULY RED RIVER FLOWS	VI-31
11	MINIMUM MONTHLY FLOWS - RED RIVER	VI-31
12	CROP YIELDS: SELECTED CROPS, IRRIGATED AND NONIRRIGATED, BOTTOMLAND SOILS, GOOD MANAGEMENT	VI-35
13	SOILS SUITABLE FOR IRRIGATION SOUTHERN MISSISSIPPI VALLEY ALLUVIUM LRA	VI-37

TABLE OF CONTENTS (cont'd)

TABLES (cont'd)

No.	Title	Page
14	POTENTIAL FUTURE DEVELOPMENT	VI-39
15	EXISTING AND FUTURE GROSS WATER REQUIREMENTS IN ACRE-FEET BY STATES AND TYPE OF IRRIGATION	VI-41
16	RED RIVER WATER QUALITY	VI-42

FIGURES

No.	Title	Page
1	TRIBUTARY BASINS AND CONSERVATION NEEDS INVENTORY WATERSHEDS	VI-7
2	MAJOR LAND RESOURCE AREAS	VI-13
3	CLASSIFICATION OF IRRIGATION WATERS	VI-44

EXHIBITS

No.	Title	Page
1	Soils Suitable for Irrigation by Tributary Basins	VI-49
2	Inventory of Irrigated and Similar Soils by Counties and Parishes	VI-50
3	Land Classified Suitable for Project-Type Irrigation	VI-52
4	Irrigated Crops, Acreages: Irrigated Cropland Harvested, Crops for which Entire Acreage was Irrigated, 1954 and 1959	VI-54
5	Harvested Acreages, Selected Crops: Irrigated and Nonirrigated, 1954 and 1959	VI-55
6	Cotton: Estimated Annual "Adjusted Normalized" Costs and Returns per Acre with Irrigation, Bottomland Soils, Good Management	VI-56

TABLE OF CONTENTS (cont'd)

EXHIBITS (cont'd)

No.	Title	Page
7	Corn: Estimated Annual "Adjusted Normalized" Costs and Returns per Acre with Irrigation, Bottomland Soils, Good Management	VI-57
8	Soybeans: Estimated Annual "Adjusted Normalized" Costs and Returns per Acre with Irrigation, Bottomland Soils, Good Management	VI-58
9	Alfalfa: Estimated Annual "Adjusted Normalized" Costs and Returns per Acre with Irrigation, Bottomland Soils, Good Management	VI-59
10	Pasture, Tame: Estimated Annual "Adjusted Normalized" Costs and Returns per Acre with Irrigation, Bottomland Soils, Good Management	VI-60
11	Prices: Adjusted Normalized for Specific Commodities, Arkansas, Louisiana, Oklahoma, Texas, and 4-State Average	VI-61
12	Costs and Returns: Adjusted Normalized, for Selected Irrigated Crops, Bottomland Soils, Good Management	VI-62
13	Costs and Returns: Adjusted Normalized, for Selected Crops Without Irrigation, Bottomland Soils, Good Management	VI-63
14	Returns above Variable Inputs and Labor: Adjusted Normalized, for Selected Crops, Irrigated and Nonirrigated, Bottomland Soils, Good Management	VI-64
15	Existing and Potential Irrigation Development	VI-65

TABLE OF CONTENTS (cont'd)

MAPS

Title	Page
General Maps Oklahoma and Texas	VI-67-VI-68
Land Classification Maps Oklahoma and Texas	VI-69-VI-73
General Map Arkansas and Louisiana	VI-74
Land Classification Maps Arkansas and Louisiana	VI-75-VI-84
REFERENCES	VI-85

APPENDIX VI

IRRIGATION

SUMMARY

Irrigation investigations were made by the U. S. Department of Agriculture and the Bureau of Reclamation in cooperation with members of the Irrigation Work Group who were designated by the Red River Basin Comprehensive Study Field Coordinating Committee. The purpose of the investigations was to appraise the potential for irrigation development in the Red River Basin Study Area and to prepare estimates of irrigation water requirements for potential developments.

Studies of irrigation project development for portions of the Study Area date back to 1948. Favorable project feasibility reports and work plans for specific project development were prepared by the Soil Conservation Service and the Bureau of Reclamation prior to the inception of the present study. Some of these projects are now under construction.

It was concluded that 765,600 acres in the Study Area have a potential for irrigation development. This area is distributed throughout the four states in the Study Area. Over 50 percent of the acreage is in Louisiana. The Southern Mississippi Valley Alluvium Land Resource Area has the greatest potential for development. Of the total area it is estimated that 317,000 acres are suitable for project-type development and 448,600 acres would be developed individually by landowners and operators. Potential project-type developments are located primarily in the Red River Alluvial Area.

Project-type potential development acreage estimates were prepared by time periods. About 57,500 acres are included in multiple-purpose projects in which construction will be initiated within the next 10-15 years. Of the remaining 259,500 acres estimated for project-type development, 129,700 acres are expected to be developed by the year 2030 and another 129,800 acres between 2030 and 2080.

Of the 448,600 acres of expected development by individuals, about 41,600 acres already are developed for irrigation. An additional area of 73,200 acres is expected to be developed by 1980. Of the remaining area of 333,800 acres, about 166,400 acres are expected to be developed by 2030 and another 167,400 acres between 2030 and 2080.

Unit water requirements were developed for each state. They are based on cropping systems generally used in the Study Area. Supplemental irrigation water requirements to provide for maximum crop needs nine out of ten years range from 2.5 feet in Louisiana to 3.0 feet in Oklahoma and Texas. Average annual water requirements range from 1.75 to 2.25 feet per acre.

Irrigation systems would be designed to provide an adequate water supply to meet the maximum requirements. Existing maximum water requirements are 114,400 acre-feet. Expected future maximum water requirements are 447,500 acre-feet in 1980, 1,252,300 acre-feet in 2030, and 2,059,700 acre-feet in 2080. About 486,800 acre-feet of the 2030 irrigation water needs would be required for project-type developments. About 765,500 acre-feet would be required for individual farm irrigation developments by 2030.

Water for existing irrigation development is obtained from surface and ground water sources. Future development of individual farm irrigation systems will continue to use both sources. All project-type irrigation developments will depend on surface water supplies. The project-type development to 1980 will depend upon storage reservoirs for a supply of irrigation water. Project-type development beyond 1980 can use Red River water as well as storage reservoirs. Improvement of Red River water quality would make the river more suitable as a source of irrigation water.

INTRODUCTION

AUTHORITY

The comprehensive study of the Red River Basin below Denison Dam was made under the overall direction of the Field Coordinating Committee comprised of a representative from each of the Federal departments and each of the cooperating states. The Field Coordinating Committee adopted the work group approach to the accomplishment of the objectives of the study. State and Federal agencies were represented on the work groups.

Chairmanship of the Irrigation Work Group was assigned to the U. S. Department of Agriculture. The Bureau of Reclamation, the Soil Conservation Service, and the Economic Research Service carried out a major portion of the field and office studies pertaining to irrigation. This appendix is a joint presentation of their investigations, findings, and conclusions, coordinated through the work group.

Investigations and reports of the Bureau of Reclamation were made under general authority of the Federal Reclamation Laws (Act of June 17, 1902, 32 Stat. 388 and Acts amendatory thereof or supplementary thereto).

The U. S. Department of Agriculture participated in the Red River Basin Comprehensive Study under authority provided by Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended). The Act is administered by the Soil Conservation Service of the USDA. It authorizes the USDA to cooperate with other Federal, State, and local groups or agencies in surveys and investigations of river basins as a basis for development of coordinated programs.

OBJECTIVES AND NATURE OF STUDY

The USDA study is necessary to develop agricultural data for the use of cooperating agencies and to prepare a potential plan of development for water and related land resources that could be accomplished under USDA programs. Agricultural data are needed by State and other Federal agencies as a basis for planning water and related land resource projects under their programs. A potential plan of development under USDA programs is needed for preparation and selection of an overall plan of potential development of water and related land resources in the basin.

The principal objectives of USDA participation in the Study included (1) preparation of a water and related land resources plan of development that would be harmonious with other elements of the

overall basin plan of development, (2) development of information needed by State and other Federal planning agencies that could be used to evaluate potential improvements under their programs, and (3) opportunities for drawing upon information developed by State and other Federal planning agencies in order to establish a potential plan of development under USDA programs that would be coordinated with programs of other agencies. Objectives also include preparation of information for subsequent use in planning P.L. 566 watershed projects, resource conservation and development projects, programs for development and management of National Forests, and other USDA action programs for water and land resource conservation, development, utilization and management.

The USDA studies included development of basic information on projections of agricultural, forestry, and related economic development, translation of the projections into needs for water and related resource uses, appraisals of the availability of water supplies both as to quantity and quality, appraisals of the availability of land resources, and descriptions of the characteristics of problems and the general approaches that appear appropriate for solutions of problems. Needs for flood control, water supply, drainage, irrigation, recreation, fish and wildlife, water quality control, stream bank stabilization, and soil conservation were considered. The basin was subdivided into tributary basins. Problems, needs, and potential for development were appraised for each watershed in the tributary basin based on field examination studies. Watersheds also were appraised to determine priorities for more detailed planning. More intensive studies were made on selected watersheds in accordance with USDA objectives for the Study.

Field examination scope studies for all watersheds were completed first. Only the minimum information necessary to make an appraisal of potential project feasibility was developed during this stage. Full use was made of existing information and supplemental information was developed as necessary for each watershed. Results of studies were summarized for all watersheds in a tributary basin in a preliminary report. The tributary basin preliminary reports were provided to cooperating agencies as soon as each report was completed.

Preliminary investigation scope studies were made in selected watersheds. These consisted of intensive studies of specific projects, the installation of which will need to be initiated within the next 10 to 15 years. Investigation reports will be prepared for potential projects in each watershed in the 10- to 15-year category.

An evaluation period extending from 1980 to 2080 was selected for use by all cooperating agencies. Basin conditions that existed on December 31, 1962, were selected to represent the planning base. All studies were oriented toward the individual watershed. These are referred to as Conservation Needs Inventory (CNI) watersheds. All investigations were restricted in detail to be consistent with Study objectives.

Objectives of Bureau of Reclamation and USDA irrigation investigations included determination of the extent of the drought problem and possible solutions. Included in the investigations were the following items:

1. Inventory of land suitable for irrigation on the basis of soil and topographic conditions in the Study Area.

2. Inventory of area irrigated, area previously irrigated, and area similar to irrigated land.

3. Inventory of currently irrigated land by crops.

4. Inventory of irrigation facilities.

5. Inventory of project type lands.

6. Inventory of water resources.

7. Appraisal of feasibility for irrigation development.

8. Potential irrigation development.

9. Irrigation water requirements for potential development.

The USDA was assigned primary responsibility for preparing three of the appendices for the Red River Basin Comprehensive Study interagency report. This appendix includes investigation results on only the irrigation studies.

DESCRIPTION OF THE STUDY AREA

The Study Area includes approximately 29,610 square miles (18,950,272 acres) in parts of Arkansas, Louisiana, Oklahoma, and Texas (figure 1). It extends from Denison Dam to the mouth of Red River and includes all of the drainage area between these points except for the drainage area of the Ouachita River and Black River and the drainage area of Concordia Parish, Louisiana. Also included in the Study Area are lower Mississippi River drainage areas that are naturally interrelated with Red River Basin drainage areas.

AGENCIES PARTICIPATING IN THE STUDY

The Bureau of Reclamation of the U. S. Department of Interior, and the USDA participated in the irrigation investigations. The Soil Conservation Service, Economic Research Service, and Forest Service participated in the USDA study. Participation of each USDA agency was coordinated through the Washington Advisory Committee and the Field Advisory Committee. The latter met on the call of the Chairman to effect coordination of USDA studies and to assure that studies were adequately coordinated with studies of other cooperating agencies.

Other cooperating agencies included the U. S. Army Engineers, the U. S. Geological Survey, Bureau of Mines, Bureau of Outdoor Recreation, and the Bureau of Sport Fisheries and Wildlife of the U. S. Department of Interior, the Weather Bureau of the U. S. Department of Commerce, the Public Health Service, the Federal Water Pollution Control Administration of the U. S. Department of Health, Education, and Welfare, and the Federal Power Commission. State agencies included the Arkansas Soil and Water Conservation Commission, Louisiana Department of Public Works, Oklahoma Water Resources Board, and Texas Water Development Board.

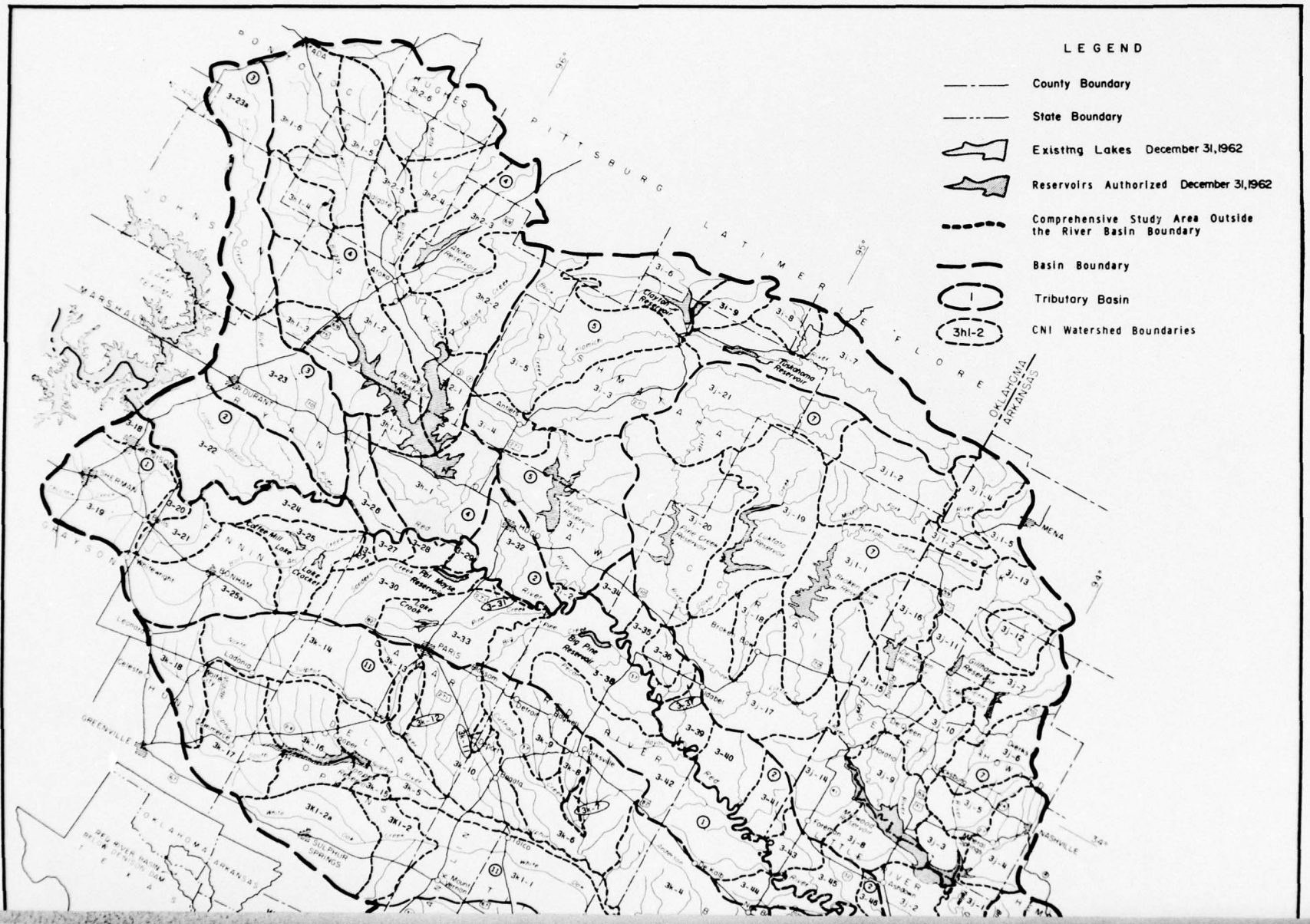
IRRIGATION PROBLEMS

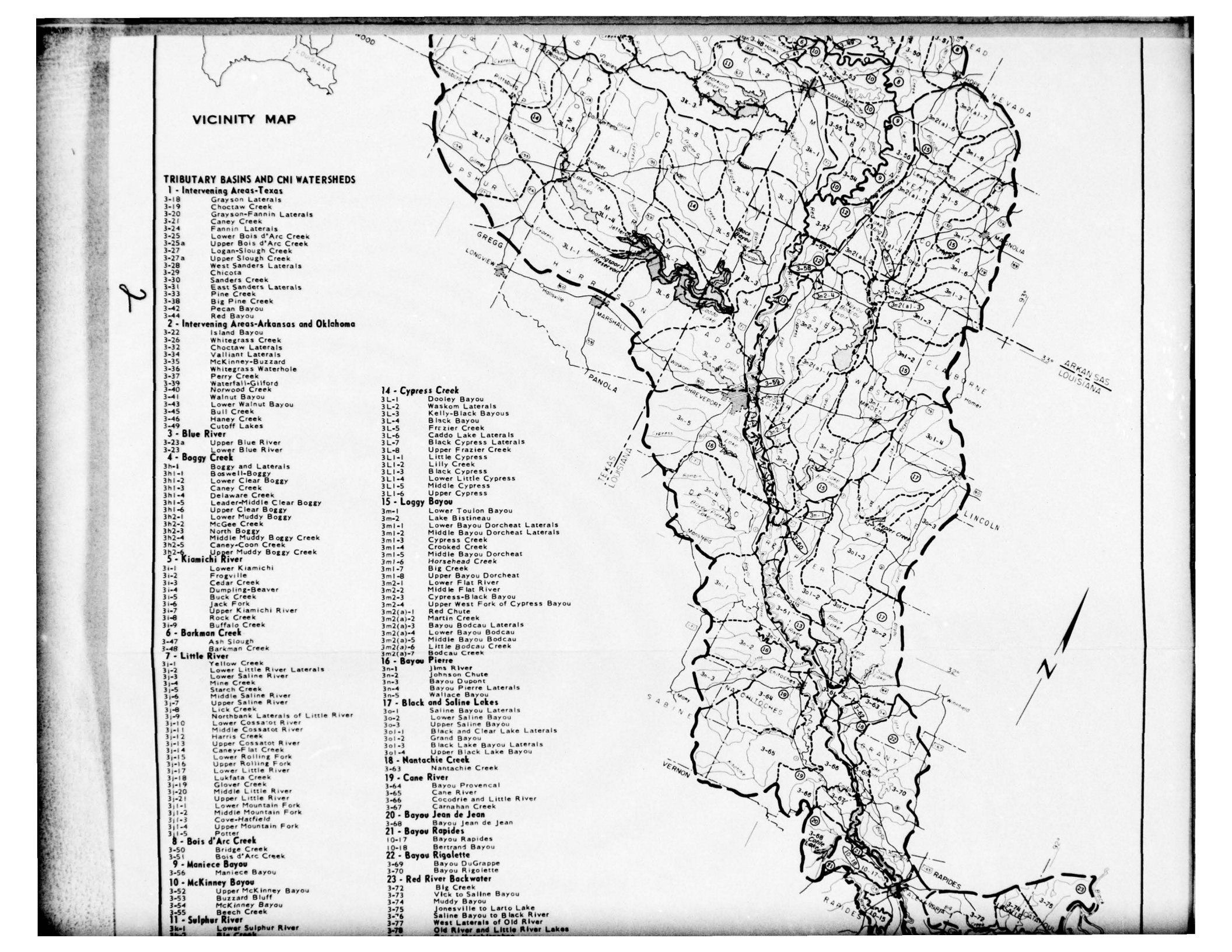
HISTORY OF INVESTIGATIONS

The problems and potentialities of the Red River Basin have been the subject of investigation over a considerable period of time.

An inventory of land and water resources, needs, and problems of the Red River Basin was initiated by the Bureau of Reclamation in 1948. While these studies were under way, an interagency investigation by the Arkansas-White-Red Basins Inter-Agency Committee (AWRBIAC) was authorized by the Flood Control Act of 1950. The Bureau studies which had been initiated earlier were continued in cooperation with other Federal agencies, under the AWRBIAC. Results of the studies were included in the report of the Committee published in 1955. The report indicated that there were some 20,000 acres of land suitable for general irrigation in the Red River Basin below Denison Dam, including the areas discussed in this report. It did not evaluate the engineering or economic feasibility of irrigating those lands, nor did it present a potential plan for irrigation development.

The drought of 1956 resulted in some private irrigation development on small tracts. Inquiries concerning irrigation potentialities were received by the Bureau of Reclamation from residents of the Red River Valley and the Oklahoma Congressional delegation. In response, the Bureau of Reclamation prepared a "Reconnaissance Report on Liberty Bottoms Project - Oklahoma and Texas" in February 1958. Investigations immediately downstream from Denison Dam found a total net irrigable area of 12,122 acres in four areas designated Colbert, Carpenter's Bluff, Liberty Bottoms, and Mulberry. Development of irrigation was found to be economically justified and the estimated payment capacity was found to be ample to pay the costs of constructing, operating, and maintaining the project works. The report pointed out that construction of the project works could be undertaken by the project interests with private financing or with Federal assistance under the Small Reclamation Projects Act of 1956. Also, upon Congressional authorization, it could be done by the Bureau of Reclamation as a Federal project.


LEGEND
County Boundary
State Boundary
Existing Lakes December 31, 1962
Reservoirs Authorized December 31, 1962
Comprehensive Study Area Outside the River Basin Boundary
Basin Boundary
1
Tributary Basin
3h1-2
CNI Watershed Boundaries
OKLAHOMA
ARKANSAS
RED RIVER BASIN
TEXAS
OKLAHOMA
ARKANSAS



2

TRIBUTARY BASINS AND CNI WATERSHEDS

1 - Intervening Areas-Texas

3-18 Grayson Laterals
3-19 Choctaw Creek
3-20 Grayson-Fannin Laterals
3-21 Caney Creek
3-24 Fannin Laterals
3-25 Lower Bois d'Arc Creek
3-25a Upper Bois d'Arc Creek
3-27 Logan-Slough Creek
3-27a Upper Slough Creek
3-28 West Sanders Laterals
3-29 Chicota
3-30 Sanders Creek
3-31 East Sanders Laterals
3-33 Pine Creek
3-38 Big Pine Creek
3-42 Pecan Bayou
3-44 Red Bayou

2 - Intervening Areas-Arkansas and Oklahoma

3-22 Island Bayou
3-26 Whitegrass Creek
3-32 Choctaw Laterals
3-34 Valliant Laterals
3-35 McKinney-Buzzard
3-36 Whitegrass Waterhole
3-37 Perry Creek
3-39 Waterfall-Gilford
3-40 Norwood Creek
3-41 Walnut Bayou
3-43 Lower Walnut Bayou
3-45 Bull Creek
3-46 Haney Creek
3-49 Cutoff Lakes

3 - Blue River

3-23a Upper Blue River
3-23 Lower Blue River

4 - Boggy Creek

3h-1 Boggy and Laterals
3h1-1 Boswell-Boggy
3h1-2 Lower Clear Boggy
3h1-3 Caney Creek
3h1-4 Delaware Creek
3h1-5 Leader-Middle Clear Boggy
3h1-6 Upper Clear Boggy
3h2-1 Lower Muddy Boggy
3h2-2 McGee Creek
3h2-3 North Boggy
3h2-4 Middle Muddy Boggy Creek
3h2-5 Caney-Coon Creek
3h2-6 Upper Muddy Boggy Creek

5 - Kiamichi River

3i-1 Lower Kiamichi
3i-2 Frogville
3i-3 Cedar Creek
3i-4 Dumpling-Beaver
3i-5 Buck Creek
3i-6 Jack Fork
3i-7 Upper Kiamichi River
3i-8 Rock Creek
3i-9 Buffalo Creek

6 - Barkman Creek

3-47 Ash Slough
3-48 Barkman Creek

7 - Little River

3j-1 Yellow Creek
3j-2 Lower Little River Laterals
3j-3 Lower Saline River
3j-4 Mine Creek
3j-5 Starch Creek
3j-6 Middle Saline River
3j-7 Upper Saline River
3j-8 Lick Creek
3j-9 Northbank Laterals of Little River
3j-10 Lower Cossatot River
3j-11 Middle Cossatot River
3j-12 Harris Creek
3j-13 Upper Cossatot River
3j-14 Caney-Flat Creek
3j-15 Lower Rolling Fork
3j-16 Upper Rolling Fork
3j-17 Lower Little River
3j-18 Lukfata Creek
3j-19 Glover Creek
3j-20 Middle Little River
3j-21 Upper Little River
3j1-1 Lower Mountain Fork
3j1-2 Middle Mountain Fork
3j1-3 Cove-Hatfield
3j1-4 Upper Mountain Fork
3j1-5 Potter

8 - Bois d'Arc Creek

3-50 Bridge Creek
3-51 Bois d'Arc Creek

9 - Maniece Bayou

3-56 Maniece Bayou

10 - McKinney Bayou

3-52 Upper McKinney Bayou
3-53 Buzzard Bluff
3-54 McKinney Bayou
3-55 Beech Creek

11 - Sulphur River

3k-1 Lower Sulphur River
3k-2 Big Creek

14 - Cypress Creek

3L-1 Dooley Bayou
3L-2 Waskom Laterals
3L-3 Kelly-Black Bayous
3L-4 Black Bayou
3L-5 Frazier Creek
3L-6 Caddo Lake Laterals
3L-7 Black Cypress Laterals
3L-8 Upper Frazier Creek
3L1-1 Little Cypress
3L1-2 Lilly Creek
3L1-3 Black Cypress
3L1-4 Lower Little Cypress
3L1-5 Middle Cypress
3L1-6 Upper Cypress

15 - Loggy Bayou

3m-1 Lower Toulon Bayou
3m-2 Lake Bistineau
3m1-1 Lower Bayou Dorcheat Laterals
3m1-2 Middle Bayou Dorcheat Laterals
3m1-3 Cypress Creek
3m1-4 Crooked Creek
3m1-5 Middle Bayou Dorcheat
3m1-6 Horsehead Creek
3m1-7 Big Creek
3m1-8 Upper Bayou Dorcheat
3m2-1 Lower Flat River
3m2-2 Middle Flat River
3m2-3 Cypress-Black Bayou
3m2-4 Upper West Fork of Cypress Bayou
3m2(a)-1 Red Chute
3m2(a)-2 Martin Creek
3m2(a)-3 Bayou Bodcau Laterals
3m2(a)-4 Lower Bayou Bodcau
3m2(a)-5 Middle Bayou Bodcau
3m2(a)-6 Little Bodcau Creek
3m2(a)-7 Bodcau Creek

16 - Bayou Pierre

3n-1 Jims River
3n-2 Johnson Chute
3n-3 Bayou Dupont
3n-4 Bayou Pierre Laterals
3n-5 Wallace Bayou

17 - Black and Saline Lakes

3o-1 Saline Bayou Laterals
3o-2 Lower Saline Bayou
3o-3 Upper Saline Bayou
3o1-1 Black and Clear Lake Laterals
3o1-2 Grand Bayou
3o1-3 Black Lake Bayou Laterals
3o1-4 Upper Black Lake Bayou

18 - Nantachie Creek

3-63 Nantachie Creek

19 - Cane River

3-64 Bayou Provencal
3-65 Cane River
3-66 Cocodrie and Little River
3-67 Carnahan Creek

20 - Bayou Jean de Jean

3-68 Bayou Jean de Jean

21 - Bayou Rapides

10-17 Bayou Rapides
10-18 Bertrand Bayou

22 - Bayou Rigolette

3-69 Bayou DuGrappe
3-70 Bayou Rigolette

23 - Red River Backwater

3-72 Big Creek
3-73 Vick to Saline Bayou
3-74 Muddy Bayou
3-75 Jonesville to Larto Lake
3-76 Saline Bayou to Black River
3-77 West Laterals of Old River
3-78 Old River and Little River Lakes

3-22 Island Bayou
3-26 Whitegrass Creek
3-32 Choctaw Laterals
3-34 Valliant Laterals
3-35 McKinney-Buzzard
3-36 Whitegrass Waterhole
3-37 Perry Creek
3-39 Waterfall-Gilford
3-40 Norwood Creek
3-41 Walnut Bayou
3-43 Lower Walnut Bayou
3-45 Bull Creek
3-46 Haney Creek
3-49 Cutoff Lakes

3 - Blue River
3-23a Upper Blue River
3-23 Lower Blue River

4 - Boggy Creek
3h-1 Boggy and Laterals
3h1-1 Boswell-Boggy
3h1-2 Lower Clear Boggy
3h1-3 Caney Creek
3h1-4 Delaware Creek
3h1-5 Leader-Middle Clear Boggy
3h1-6 Upper Clear Boggy
3h2-1 Lower Muddy Boggy
3h2-2 McGee Creek
3h2-3 North Boggy
3h2-4 Middle Muddy Boggy Creek
3h2-5 Caney-Coon Creek
3h2-6 Upper Muddy Boggy Creek

5 - Kiamichi River
3i-1 Lower Kiamichi
3i-2 Frogville
3i-3 Cedar Creek
3i-4 Dumpling-Beaver
3i-5 Buck Creek
3i-6 Jack Fork
3i-7 Upper Kiamichi River
3i-8 Rock Creek
3i-9 Buffalo Creek

6 - Barkman Creek
3-47 Ash Slough
3-48 Barkman Creek

7 - Little River
3j-1 Yellow Creek
3j-2 Lower Little River Laterals
3j-3 Lower Saline River
3j-4 Mine Creek
3j-5 Starch Creek
3j-6 Middle Saline River
3j-7 Upper Saline River
3j-8 Lick Creek
3j-9 Northbank Laterals of Little River
3j-10 Lower Cossatot River
3j-11 Middle Cossatot River
3j-12 Harris Creek
3j-13 Upper Cossatot River
3j-14 Caney-Flat Creek
3j-15 Lower Rolling Fork
3j-16 Upper Rolling Fork
3j-17 Lower Little River
3j-18 Lukfata Creek
3j-19 Glover Creek
3j-20 *Middle Little River*
3j-21 Upper Little River
3j1-1 Lower Mountain Fork
3j1-2 Middle Mountain Fork
3j1-3 Cove-Hatfield
3j1-4 Upper Mountain Fork
3j1-5 Potter

8 - Bois d'Arc Creek
3-50 Bridge Creek
3-51 Bois d'Arc Creek

9 - Maniece Bayou
3-56 Maniece Bayou

10 - McKinney Bayou
3-52 Upper McKinney Bayou
3-53 Buzzard Bluff
3-54 McKinney Bayou
3-55 Beech Creek

11 - Sulphur River
3k-1 Lower Sulphur River
3k-2 Big Creek
3k-3 Lower Sulphur Laterals
3k-4 Anderson Creek
3k-5 South Sulphur Laterals
3k-6 Cuthand Creek
3k-7 Sand Branch
3k-8 Langford Creek
3k-9 Bruton Creek
3k-10 Sand-Mustang Laterals
3k-11 Deport Area
3k-12 Click Creek
3k-13 Auds Creek
3k-14 Upper North Sulphur River
3k-15 Morgan Creek
3k-16 South Sulphur
3k-17 South Sulphur River, Middle Sulphur River & Pecan Creek
3k-18 Upper South Sulphur River
3k1-1 Lower White Oak Bayou
3k1-2 White Oak Laterals
3k1-2a White Oak Bayou

12 - Posten Bayou
3-57 Posten Bayou
3-57a Lower Posten Bayou

13 - Red River Main Stem
3-58 Holm Lake
3-59 Sunny Point and Half Moon Lake
3-60 East Point
3-61 Bull Lake and Sims Bayou
3-62 St. Maurice and Dunn Lakes
3-71 Wiggins Bayou

14 - Cypress Creek
3L-1 Dooley Bayou
3L-2 Waskom Laterals
3L-3 Kelly-Black Bayous
3L-4 Black Bayou
3L-5 Frazier Creek
3L-6 Caddo Lake Laterals
3L-7 Black Cypress Laterals
3L-8 Upper Frazier Creek
3L1-1 Little Cypress
3L1-2 Lilly Creek
3L1-3 Black Cypress
3L1-4 Lower Little Cypress
3L1-5 Middle Cypress
3L1-6 Upper Cypress

15 - Loggy Bayou
3m-1 Lower Toulon Bayou
3m-2 Lake Bistineau
3m1-1 Lower Bayou Dorcheat Laterals
3m1-2 Middle Bayou Dorcheat Laterals
3m1-3 Cypress Creek
3m1-4 Crooked Creek
3m1-5 Middle Bayou Dorcheat
3m1-6 *Horsehead Creek*
3m1-7 Big Creek
3m1-8 Upper Bayou Dorcheat
3m2-1 Lower Flat River
3m2-2 Middle Flat River
3m2-3 *Cypress-Black Bayou*
3m2-4 Upper West Fork of Cypress Bayou
3m2(a)-1 Red Chute
3m2(a)-2 Martin Creek
3m2(a)-3 Bayou Bodcau Laterals
3m2(a)-4 Lower Bayou Bodcau
3m2(a)-5 Middle Bayou Bodcau
3m2(a)-6 Little Bodcau Creek
3m2(a)-7 Bodcau Creek

16 - Bayou Pierre
3n-1 Jims River
3n-2 Johnson Chute
3n-3 Bayou Dupont
3n-4 Bayou Pierre Laterals
3n-5 Wallace Bayou

17 - Black and Saline Lakes
3o-1 Saline Bayou Laterals
3o-2 Lower Saline Bayou
3o-3 Upper Saline Bayou
3o1-1 Black and Clear Lake Laterals
3o1-2 Grand Bayou
3o1-3 Black Lake Bayou Laterals
3o1-4 Upper Black Lake Bayou

18 - Nantachie Creek
3-63 Nantachie Creek

19 - Cane River
3-64 Bayou Provencal
3-65 *Cane River*
3-66 Cocodrie and Little River
3-67 Carnahan Creek

20 - Bayou Jean de Jean
3-68 Bayou Jean de Jean

21 - Bayou Rapides
10-17 Bayou Rapides
10-18 Bertrand Bayou

22 - Bayou Rigolette
3-69 Bayou DuGrappe
3-70 Bayou Rigolette

23 - Red River Backwater
3-72 Big Creek
3-73 Vick to Saline Bayou
3-74 Muddy Bayou
3-75 Jonesville to Larto Lake
3-76 Saline Bayou to Black River
3-77 West Laterals of Old River
3-78 Old River and Little River Lakes
3-81 Bayou Natchitoches

24 - Chatlin Lake and Associated Area
10-6 Pomme de Terre
10-10 Waukasha-Courtableau
10-11 Bayou Grand Louis
10-12 Bayou Cocodrie
10-13 Bayou Rouge
10-14 Bayou Des Glaises
10-15 Bayou Boeuf
10-16 Chatlin Lake
10-19 Upper Bayou Cocodrie

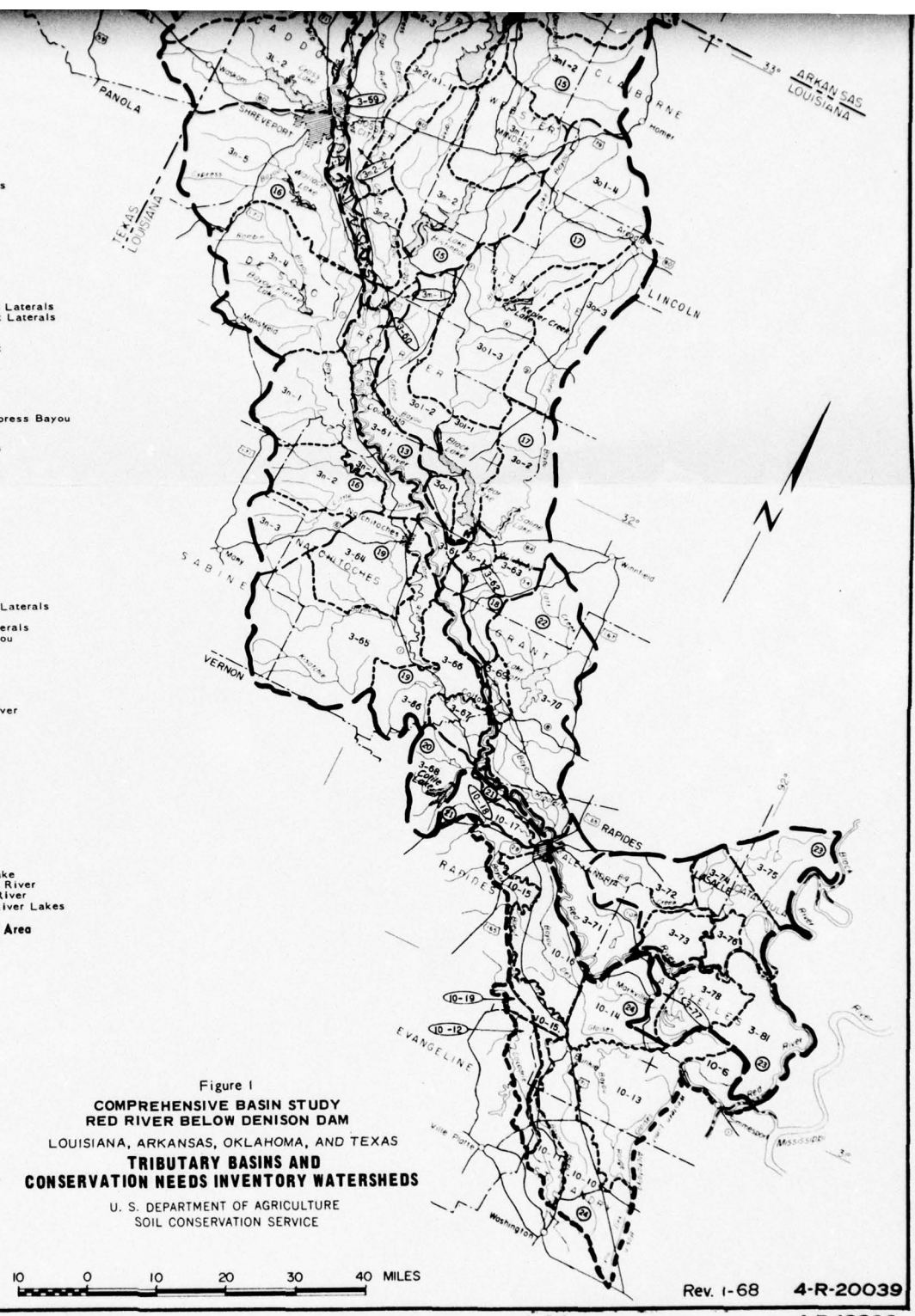


Figure 1

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM

LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS

TRIBUTARY BASINS AND CONSERVATION NEEDS INVENTORY WATERSHEDS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Rev. 1-68 4-R-20039

OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS
EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS.

USDA-SCS-FORT WORTH, TEX. 1968

3-64

4-R-18830

VI-7

3

Following review of the Liberty Bottoms reconnaissance report, representatives of the Oklahoma Water Resources Board, the County Agricultural Agent of Bryan County, and representatives of the Bureau of Reclamation met with farmers and townspeople to explain findings of the report and to discuss potentialities for irrigation development. In July 1959, a group of Bryan County farmers and others submitted a formal statement to the Bureau of Reclamation, expressing interest in further study of the potential project by the Bureau. As a result of this expression, detailed investigations were initiated on about 5,000 acres in the Liberty Bottoms area. Investigations were limited to the Liberty Bottoms area because it forms the largest contiguous body available, and because the lands are located in the portion of Bryan County in which owners expressed interest in further studies. The Liberty Bottoms feasibility report, recommending construction as a Federal project, was completed in November 1963. Since that time, about one-fifth of the project lands have been provided irrigation facilities by private means.

In response to a request from the Corps of Engineers, Tulsa District, an investigation was made during calendar year 1962 to locate and determine water requirements for areas physically suitable for irrigation which are located within 30 miles either side of a water conveyance canal proposed by the Corps in its survey report on the Central Oklahoma Project. The canal would originate at the authorized Hugo reservoir on the Kiamichi River and extend some 165 miles northwest to the vicinity of Oklahoma City. Reconnaissance grade investigations found about 21,000 acres of arable lands in scattered tracts along the canal in the Red River Basin. These lands are located in the Boggy Creek and Blue River Tributary Basins.

Favorable findings by the Liberty Bottoms Project report served to increase interest in the development of irrigation along the Red River downstream from the Liberty Bottoms area. Inquiries concerning potentialities were received by the Bureau of Reclamation from residents of the basin and from members of the Oklahoma Congressional delegation. In response, the Bureau undertook reconnaissance appraisals of downstream areas entitled the "Goodland Project." These studies, completed in June 1963, found some 12,400 acres suitable for irrigation in seven locations designated as Yuba, Telephone, Riverby, Direct, Boggy Cutoff, Shoals Chapel, and Slate Shoals. Of this total, some 7,400 acres were selected for analysis. The inclusion of 10 percent vegetable production in the farm program was believed justified on the basis that lands are suitable to vegetable production and a new food processing plant constructed near Paris, Texas by the Campbell Soup Company constitutes a potential market for vegetables. As in the Liberty Bottoms study, it was stated that the Goodland Project areas could be constructed by projects interests with private financing; with Federal assistance under the Small

Reclamation Projects Act of 1956; or upon Congressional authorization, by the Bureau of Reclamation as a Federal project. Further investigations have been deferred pending authoritative action by project interests.

Investigations for the Liberty Bottoms and Goodland projects, summarized above, covered roughly the upper half of the mainstem and minor tributaries area between Denison Dam and Index, Arkansas. Following establishment of the comprehensive basin study, in fiscal year 1963, supplemental investigations were conducted in the remainder of the Study Area. The purpose of the supplemental studies was to locate and appraise areas most suitable for project-type development. Areas were included which might be partially or completely supplied with water from various sources, such as: ground water, storage reservoirs, and regulated and unregulated flows of the Red River and its tributaries. It is considered that such areas might be developed in the future (1) by local interests or groups of local interests with private financing, (2) with Federal assistance under P.L. 566, (3) with Federal assistance under the Small Reclamation Projects Act of 1956, or (4) by the Bureau of Reclamation as Federal Projects upon Congressional authorization.

Bureau of Reclamation appraisals were made of the potential long-range irrigation development in each of the states and coordinated with the Oklahoma Water Resources Board, the Texas Water Development Board, and the Soil Conservation Service.

Results of the Bureau studies in Oklahoma and Texas were summarized in a report entitled "Irrigation Investigations for Red River Below Denison Dam (Part I) Oklahoma and Texas, July 1966," and the investigations of the Arkansas and Louisiana portion of the basin were covered in "Part II, Arkansas and Louisiana, January 1967."

NATURE AND EXTENT OF IRRIGATION PROBLEM

Assuming that an adequate supply of suitable water is available, economic feasibility of irrigating specific crops becomes a prime factor. Studies indicate that benefits from supplemental irrigation of selected agricultural enterprises will justify a reasonable cost for providing a water supply. Irrigation is an expensive undertaking and requires a high level of management in order to be profitable to the operator.

Although the untimely distribution of precipitation greatly increases the risks involved in agricultural production, thereby bringing about the desirability for supplemental irrigation, many other factors are involved.

Distribution of available water for irrigation use is a problem which must be considered individually for each enterprise, due to

variable circumstances. Types of farming, labor, and local markets can all be involved in problems relating to irrigation. The human element, due to its complexity, also enters into consideration of irrigation the same as it does for any other enterprise.

The value of irrigation has been recognized by operators who are presently irrigating about 42,000 acres of cropland. Technological advances and future production efficiency needs will accelerate irrigation development.

General Description of Inventory Studies

During the irrigation studies, data were assembled for inventory of land suited to irrigation from a soils and topographic standpoint, areas presently and previously irrigated, soils similar to those irrigated, crops irrigated, and irrigation water resources. Other items of study included availability of water, cost-return data for various crops with irrigation, and potential irrigation in the Red River Basin.

Although land suited to irrigation from a soils and topographic standpoint, regardless of land use, was considered the maximum acreage which could be irrigated, only a portion of this inventory acreage was considered to have a real potential for irrigation.

Source of Data

The USDA used the National Conservation Needs Inventory (CNI) of 1958 and Soil Conservation Service irrigation guides for each state to determine the area which has a physical potential for irrigation development from a soils and topographic viewpoint. CNI laboratory print-out sheets were obtained. These contained tabulations of slope, erosion, and land use conditions and acreages for each combination of conditions. CNI data were further subdivided into state, county or parish, land resource area, and river subbasins in the print-out sheets. Acreage data were extracted from print-out sheets for soil units that were included in the state irrigation guides.

Another inventory of potentially irrigable land was compiled for land similar to that which was irrigated. This was obtained by questionnaires completed by Soil Conservation Service personnel in each county or parish in the Red River Basin. The questionnaires also included data concerning acreages currently and previously irrigated, crops irrigated, and available resources for irrigation. The questionnaires were mailed to Soil Conservation Service work units in Arkansas and Oklahoma by the USDA Red River Basin Office and applied to 1963 conditions. Similar data for Texas were obtained from Texas Water Commission Bulletin 6515 for 1964.

Data for project-type irrigation developments were compiled from field surveys by the Bureau of Reclamation, from P.L. 566 watershed work plans, and from USDA preliminary investigation scope studies in selected watersheds.

Census data for irrigated cropland harvested, by states for 1954 and 1959, compiled by the Economic Research Service, includes acreages for entire counties or parishes that are wholly or partly within the Red River Basin. These data had only limited value for evaluating the potential irrigable area.

Criteria for Problem Area Determination

Several criteria were used to evaluate the potential for irrigation development in the Study Area. The Soil Conservation Service utilized irrigation guides for the states involved. These provided basic data for the overall land resources. The Soil Conservation Service also employed a questionnaire survey to determine the extent of present irrigation and the potential for irrigation. This survey produced results based on the knowledge and judgment of experienced local agricultural workers. The Bureau of Reclamation used its reconnaissance land classification procedures to survey the potential for project-type irrigation.

Soil Conservation Service Irrigation Guides

A reasonable maximum physical potential for irrigation development was established by considering the land resource base. Possibilities for irrigation development by major land resource areas (figure 2) and tributary basins were explored. The following soil units were included in each land resource area:

Major Land Resource Area	Arkansas	Louisiana	Texas
Southern Mississippi Valley Alluvium (131)	3al,3a,4,4al, 4a,8,8al,8a, 9, & 15	3a,3al,3Zal, 4al,4Zal,4Yal, 8Yal,8al,8,9,15	3,3a,4a,4al, 4,4X,8a,8, & 9
Southern Coastal Plain (133) and Ouachita Mountains (119)	6,6al,7,8, 8al, & 9	5,5a,5al,6,6a, 6al,7,7X,8al,8, 12, & 13	5,5al,6,6al, 7,7a,8,8al, 9,11,12,& 13
Texas Blackland Prairie (86)	2 & 4	-	2,2X,4,4X,5, 6,8, & 9
Southern Mississippi Valley Silty Uplands (134)	-	6,6al,6a,7,8, 8al	-


HUGHES
PITTSBURG
LATIMER
LE FLORE
MURRAY
JOHNSTON
MARSHALL
LAKE TEXOMA
PUSHMATAHA
BRYAN
OKLAHOMA
TEXAS
CHOCTAW
MC CURTAIN
OKLAHOMA
ARKANSAS
POLK
GRAYSON
FANNIN
LAMAR
DELTA
RED RIVER
HUNT
HOPKINS
FRANKLIN
TITUS
BOWIE
SEVIER
HOWARD
LITTLE RIVER
HEMPSTEAD
NEVADA
WOOD
CAMP
MORRIS
CASS
MILLER
UPSHUR
MARION
LAFAYETTE
COLUMBIA
GREGG
HARRISON
TEXAS
LOUISIANA
ARKANSAS
LOUISIANA
CADDO
SSIER
WEBSTER
CLAIBORNE
PANOLA
LEGEND
Basin Boundary
Comprehensive Study Area Outside The River Basin Boundary
State Boundary

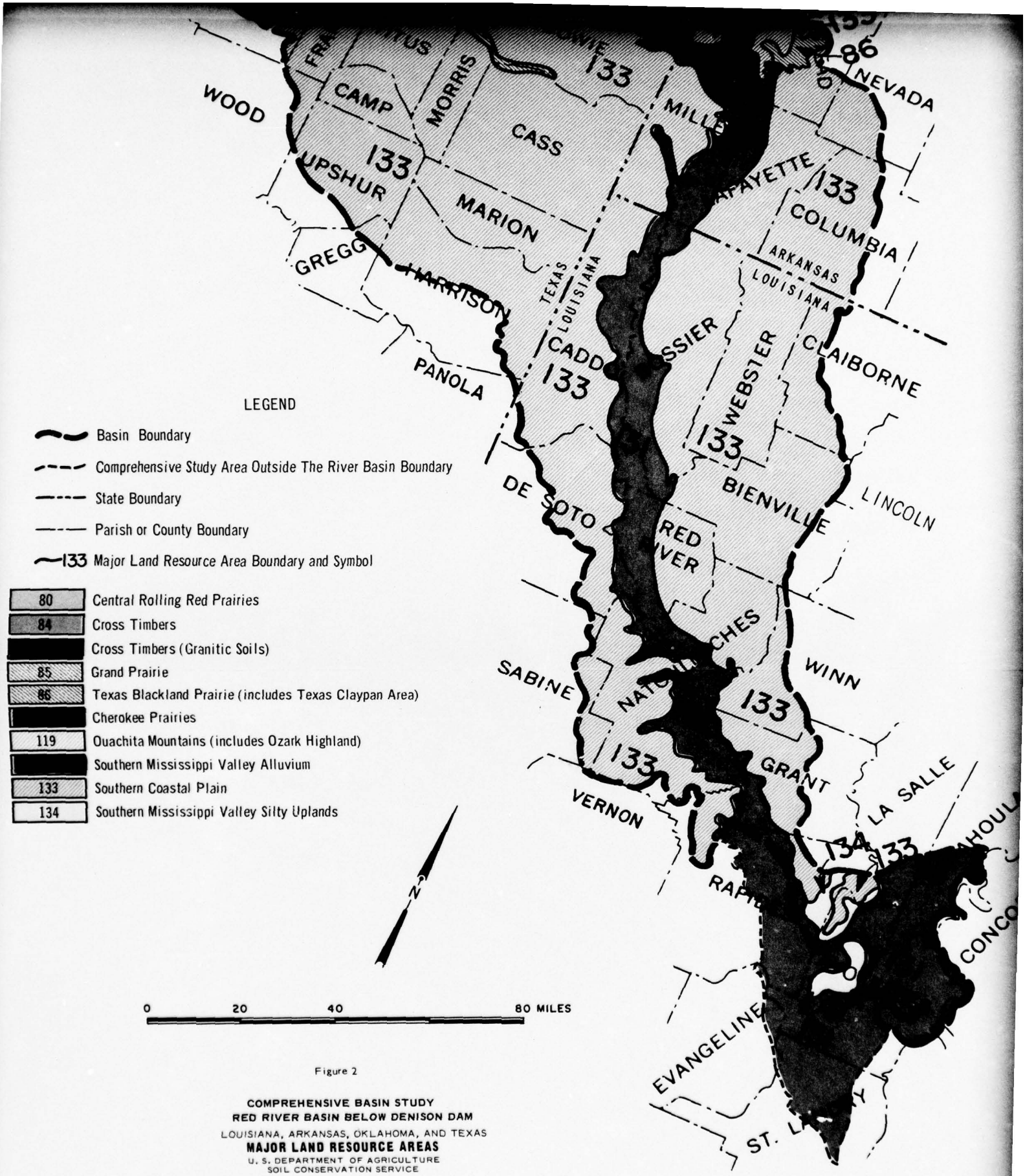


Figure 2

COMPREHENSIVE BASIN STUDY
RED RIVER BASIN BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
MAJOR LAND RESOURCE AREAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Rev. 1-68 4-R-2

USDA-SCS-FORT WORTH, TEX. 1968

Acreages for soil units 1, 2, 3, 3H, 4, 4H, 5, 6, 7, 7a, 7X, 8, 8H, 9, 9H, 12, 12X, 15, and 15h were included for all land resource areas in Oklahoma.

The symbols identify soil characteristics such as soil depth, texture, permeability, and inhibitory factors, such as degree of wetness and flooding. Soil units are designated by numbers. Soil units are described as follows:

Soil Unit 1 - Deep, fine textured, very slowly permeable soils

Soil Unit 2 - Deep, fine textured, slowly permeable soils

Soil Unit 3 - Deep, fine textured, very slowly permeable bottomland soils

Soil Unit 4 - Deep, fine textured, slowly permeable bottomland soils

Soil Unit 5 - Deep, medium textured, very slowly permeable soils

Soil Unit 6 - Deep, medium textured, slowly permeable soils

Soil Unit 7 - Deep, medium textured, moderately permeable soils

Soil Unit 7X - Deep, medium textured, moderately rapidly permeable soils

Soil Unit 8 - Deep, medium textured, slowly permeable bottomland soils

Soil Unit 9 - Deep, medium textured, moderately permeable bottomland soils

Soil Unit 12 - Deep, coarse textured, moderately permeable soils

Soil Unit 12X - Deep, coarse textured, moderately rapidly permeable soils

Soil Unit 13 - Deep, coarse textured, rapidly permeable soils

Soil Unit 15 - Deep, coarse textured, rapidly permeable bottomland soils

Degree of wetness is indicated by symbols "a" or "al" following the soil unit designation. The former symbol includes moderately wetland and the latter includes slightly wetland. Installation of

drainage measures on land areas in this category would be a prerequisite to successful irrigated agriculture.

All bottomland soil classified in the above units may be overflowed occasionally. Soil units that are seldom, if ever, overflowed are designated by the capital letter "H" following the soil unit number as, 9H. Soils with frequent damaging overflow were not considered to have a potential for irrigation development.

Special symbols are included for Louisiana. The capital letter "Z" added to the soil unit number indicates sandy or gravelly substrata, as 3Z. The capital letter "Y" added to the soil unit number indicates dense clay, very slowly permeable substrata, as 8Y.

Acreages of the tabulated conditions in each state were restricted to topography with slopes of three percent or less and included all major land uses. Only slight and moderate soil erosion conditions were included.

Soil Conservation Service Questionnaires

To obtain information regarding the status of irrigation and irrigation facilities in the Red River Basin, questionnaires were submitted by the USDA Red River Basin Office to each Soil Conservation Service Work Unit in Arkansas, Louisiana, and Oklahoma, which serves a county or parish located wholly or partly within the Study Area. The approach of determining potentially irrigable lands on the basis of land similar to that which has been irrigated from estimates by agricultural workers familiar with the areas of each county or parish, provided additional guides for estimating potential irrigation development. Questionnaires were patterned after Texas Board of Water Engineers Bulletin 6018, which has been superseded by Texas Water Commission Bulletin 6515 and includes data for Texas.

Data inventoried for the Study Area by counties from the questionnaires and Texas Water Commission Bulletin 6515 include: (1) Total Area Irrigated in 1963*; (2) Total Area Previously Irrigated, but not in 1963*; and (3) Total Area Similar to Irrigated Soils.

The estimated acreage previously irrigated is considered still suitable and available for irrigation, often with irrigation systems intact, but for one reason or another was not irrigated in the year indicated. Some of this is in the rice area or where normal rotational practice subjects only a portion of the rotationally farmed area to actual irrigation in any given year.

---

*Texas Data for 1964

The area similar to irrigated soils includes estimates of non-irrigated land with topographic and soil conditions similar to those that have been irrigated. In general, this category is composed of only the deep, fertile soils, which are level or with only slightly sloping land surface that would not unduly limit efficient water use. These soils have water intake rates and storage capacities in the root zone of crops favorable for irrigation. Acreage included may have water from surface or ground sources available for irrigation use, but not necessarily so. Water availability was not a consideration in setting up this classification.

Bureau of Reclamation Land Classification Standards

Reconnaissance land classification was used by the Bureau of Reclamation to identify area suitable for project-type development. The object of reconnaissance land classification is to determine the location, extent, and class of project lands suitable for sustained irrigation. To accomplish this objective, the usual basic criteria for reconnaissance land classification were used, as set forth in the Bureau of Reclamation Manual. Soils, topography, and drainage are the basic factors considered, with combinations of these interacting to result in the specific land classification. The segregations used are classes one, two, and three, arable, and class six, nonarable. These classes have been subdivided into subclasses to reflect the various operating deficiencies.

The following terms and definitions are pertinent to Bureau of Reclamation criteria.

Arable land is land which, in adequate sized units and if properly provided with the essential improvements of leveling, drainage, and irrigation facilities, would have a productive capacity under sustained irrigation sufficient to (1) meet all production expenses including irrigation operation and maintenance cost and a reasonable return of the farm investment, (2) repay the installation costs of irrigation facilities, and (3) provide a satisfactory level of living for the farm family.

Irrigable land is the arable land under a specific plan for which a water supply is or can be made available, and which is provided with or planned to be provided with irrigation, drainage, flood protection, and other facilities as necessary for sustained irrigation.

Class 1 arable lands are highly suitable for irrigation farming and are capable under good management of producing sustained high yields of a wide variety of climatically adapted crops at reasonable costs. Class 1 land is characterized by smooth, very gentle slopes. The soils are friable, with good texture, and drainage is generally favorable.

Class 2 arable lands are suitable for irrigation farming but are slightly inferior to Class 1 lands. If the limitation on this land is a soil deficiency, it will be lower than Class 1 land in productivity or be adapted to a narrower range of crops. If topography or drainage is the limitation, development and operation requirements will be more costly and difficult than for Class 1. Class 2 land may be limited with respect to topography, texture, permeability, or soil structure. Topographic limitations include uneven surfaces requiring moderate costs for leveling, or short, slightly steep slopes requiring special care to prevent erosion. Existing or anticipated drainage problems should be correctable or controlled at reasonable costs.

Class 3 arable land is suitable for irrigation development, but is marginal and of distinctly restricted suitability for diversified irrigation farming because of more extreme deficiencies in soil, topography, or drainage than described in Class 2 land. This land may have topography favorable for irrigation, but because of inferior soils, crop adaptability and yield, crop income is limited. Class 3 land may require special irrigation or management practices or special drainage precautions.

Class 4 arable land is suitable for irrigation under special conditions or special crops. They may have one or more excessive, noncorrectable deficiencies, thereby limiting their utility to meadow, pasture, orchard, or other relatively permanent crops. They are capable of supporting a farm family and meeting water charges if operated in units of adequate size or in association with better lands. No general standards are available for this land class. Limitation of time and funds would not permit delineation of Class 4 lands, except for sprinkler irrigation lands, which is treated in a subsequent paragraph entitled "Special Irrigation Land Classification."

Class 5 nonarable land is nonarable under existing conditions, but has potential for future irrigation providing certain corrective measures, such as flood control and drainage, are made prerequisite to development for irrigation. It is a temporary category which reserves the lands for more detailed studies which are beyond the scope of this investigation. Consequently, lands in this category are included with the Class 6 lands for the purpose of this report.

Class 6 land is not considered suitable for development under present economic and farming conditions. It has limited utility, and net returns from crop yields under average management are not sufficient to pay water charges in addition to other necessary expenses. It may include small tracts of arable land that do not warrant segregation, or arable land that lies too high, topographically, to be served by proposed irrigation facilities. Generally, it comprises land that is steep, rough, and badly eroded; land with very coarse or very fine textured soils; and land with shallow soils over

shale or sandstone. Any one of these factors may cause this land to be nonarable, but frequently a combination of deficiencies exists.

Standards for determining the suitability of land for gravity irrigation are shown in table 1. Erosion problems can easily develop in land in row crops in high rainfall areas. Experience in areas similar to the Red River Valley indicates that row slopes on cultivated crops should not exceed about 0.5 of a percent. The land development costs in table 1 establish monetary limits for land classification purposes. Additional amounts could be expended by individual farmers for convenience in farming, ease of handling water, and other farm operations.

Special Irrigation Land Classification criteria were used for special conditions relating to specific soils, crops, or irrigation methods. Lands unsuited for gravity irrigation, but which could be irrigated by the sprinkler method, and riceland, were inspected along with lands suitable for irrigation of general crops by gravity method. Specifications used for sprinkler and riceland on the reach of the Red River between Frogville, Oklahoma and Index, Arkansas, also apply to the lower reach from the Oklahoma-Arkansas state line to the confluence of the Red and Mississippi Rivers. The specifications used are as follows:

Sprinkler Irrigation Specifications. Lands considered for sprinkler-type irrigation include the following:

1. Land of irregular and pothole topography which cannot be leveled for surface methods within reasonable cost or without exposing too large a proportion of intractable subsoil.

2. Land so steep that surface methods would result in excessive erosion or cost of application of water.

3. Isolated high areas which cannot be reached by gravity ditches.

4. Soil so thin or porous that excessive losses by deep percolation occur when surface methods are used.

Riceland Specifications. Profitable rice production requires level, rich land with an impervious subsoil. Only fertile land or land in which fertility can be built up economically is recommended for rice production. Tight soils are adaptable to rice production, but unless they are underlain by a heavy layer of soil within two or three feet, and have less than .01 of an inch per hour permeability rate, the soil will not hold the water and irrigation costs will make rice production very costly. Good surface drainage is necessary for successful rice production. It permits uniform drying

of the soil, thus making possible more timely and satisfactory seed bed preparation and harvesting. Good drainage also aids in control of certain diseases and insects. A pH of 5.5 to 6.5 is most favorable for rice production. Continuous use of irrigation water containing more than 600 p.p.m. of sodium, 50 p.p.m. of calcium, or 10 p.p.m. of magnesium salts may result in increasing the pH to a level that is less favorable for rice production.

Area Inventory

The inventory of land suited for irrigation based on the SCS irrigation guides gave a total of 6,187,690 acres in this category in the Study Area. This acreage was composed of 946,040 acres in Arkansas, 2,477,000 acres in Louisiana, 834,350 acres in Oklahoma, and 1,930,300 acres in Texas. Exhibit 1 includes breakdowns of these acreages by tributary basins. These soils were considered physically suited for irrigation, without consideration of water availability, economic feasibility, present land use, production needs, local interest, and the human elements involved.

A summary of irrigated and similar land by counties or parishes as compiled from the questionnaires, is shown in the exhibit 2. Total acreages by states are summarized in table 2.

Table 1 - LAND CLASSI

Red
Red Rive

Land Characteristics	Class 1	Class 2
1. Texture	Sandy loam to very permeable clay.	Loamy sand to pe
2. Depth (minimum) To sands or gravel.	36" plus - good free working soil of fine sandy loam or finer; 42" of sandy loam.	24" plus - fine finer; 30" - 36" to loamy sand.
To shale, raw soil from shale or similar material.	60" plus; or 54" with minimum of 6" of gravel overlying impervious material or sandy loam throughout.	48" plus, or 42" of 6" of gravel impervious materi sand throughout.
To penetrable lime zone.	18" with 60" penetrable.	14" with 48" pene
3. Alkalinity	pH less than 9.0 unless soil is calcareous, total salts are low. Exchangeable sodium negligible.	pH less than 9.0 is calcareous, t low. Exchangeabl negligible.
4. Salinity	Total salts not to exceed 0.2% or conductivity of saturation extract 4 mmhos or less. May be higher under excellent drainage conditions.	Total salts not 0.5% or conducti saturation extrac or less. May be good drainage co
1. Slopes	General gradient not to exceed 1%.	General gradient 2%.
2. Surface and Cover (vegetation)	Even enough to require only small amount of leveling and no heavy grading. Total leveling and clearing costs not exceed $50 per A.*	Moderate grading amounts found fe developing tract and clearing cost $100. per A.*
1. Soil and topography	Soil and topography such that little or no specific farm drainage required. Farm drainage costs when combined with leveling and clearing costs not to exceed $50. per A.*	Soil and topograp some farm drainag required, but co with leveling an not exceed $100.

*Based on index of 250 (1910-14 = 100)

LAND CLASSIFICATION SPECIFICATIONS FOR GRAVITY IRRIGATION

Red River Basins
Red River below Denison Dam

Class 2	Class 3	Class 6
SOILS		
y sand to permeable clay.	Loam sand to slowly permeable clay.	Includes lands which do not meet the minimum requirements for the other land classes and are not suitable for irrigation. They include: lands with very shallow or stony soils, impermeable subsoils, excessive concentrations of salt, pH above 9.0 and more than 15% exchangeable sodium, low available moisture capacity; rough hummocky and severely channel-dissected bottomlands, large dunes, overflow and runoff channels not susceptible of fill or other correction and use; heavily timbered bottom-lands; permanent waste and sump areas; short steep slopes between terraces and steep slopes bordering valley lands; small, isolated arable tracts not susceptible to delivery of irrigation water so far as the proposed plan is concerned; and other obviously non-arable areas, such as small bodies of arable land lying within large bodies of non-arable land when these would obviously not make usable fields.
plus - fine sandy loam or r; 30" - 36" of sandy loam loamy sand.	18" plus-fine sandy loam or finer; 24" - 30" of sandy loam to loamy sand.	
plus, or 42" with minimum " of gravel overlying rvious material or loamy throughout.	42" plus; or 36" with minimum of gravel overlying impervious material or loamy sand throughout.	
with 48" penetrable.	10" with 36" penetrable.	
ess than 9.0 unless soil alcareous, total salts are Exchangeable sodium igible.	pH 9.0 or less unless soil is calcareous, total salts are low. Exchangeable sodium less than 15%.	
l salts not to exceed or conductivity of ration extract 8 mmhos ss. May be higher under drainage conditions.	Total salts not to exeed 0.6% of or conductivity of saturation extract 12 mmhos or less. May be higher under good drainage conditions.	
TOPOGRAPHY		
al gradient not to exceed	General gradient not to exceed 3%.	
ate grading required but in ts found feasible in loping tracts. Total leveling learing costs not to exceed per A.*	Heavy grading required but within feasible limits in developed tracts. Total leveling and clearing costs not to exceed $200. per A.*	
DRAINAGE		
and topography such that farm drainage will be red, but costs when combined leveling and clearing, shall xceed $100. per acre.*	Soil and topography such that significant farm drainage will be required, but costs, when combined with leveling and clearing shall not exceed $200 per acre.*	

00)

TABLE 2 - IRRIGATED AND SIMILAR LAND
Red River Basin Study Area

State	Area Irrigated in 1963 (acres)	Area Previously Irrigated but not in 1963 (acres)	Area Similar to Irrigated Soils (acres)	Total Irrigated Similar Soils (acres)
Arkansas	6,709	3,692	430,500	440,901
Louisiana	23,424	4,682	912,586	940,692
Oklahoma	4,713	6,010	157,500	168,223
Texas 1/	6,844	19,396	570,280	596,520
Total	41,690	33,780	2,070,866	2,146,336

1/Data for 1964, Texas Water Commission Bulletin 6515

Although the approximately 2,146,000 acres are considered potentially irrigable, irrigation is not anticipated on the entire acreage.

Application of the land classification specifications prepared by the Bureau of Reclamation resulted in the selection of 37 areas for consideration as potential project-type developments. Land classification results for each of the 37 areas are shown in exhibit 3. There are 84,989 acres of class 1 land, 96,090 acres of class 2 land, and 37,537 acres of class 3 land for a total of 218,616 acres of gravity type arable land suitable for project-type development. In addition, there are 14,084 acres of sprinkler irrigation land and 63,858 acres of riceland. There are 296,558 acres of project-type land in the Red River Basin below Denison Dam which could be developed for some form of irrigation. In addition, there are 20,920 acres of upland in Oklahoma in the Blue and Muddy Boggy basins which were designated as arable for the Corps of Engineers' Central Oklahoma Project. This makes a grand total of 317,478 acres of project-type lands suitable for irrigation.

The areas classified are shown on a series of maps covering the reach from Denison Dam to the Mississippi River. General Maps of the Oklahoma-Texas portion are numbered 62-514-26 and 62-514-17. The General Map of the Arkansas-Louisiana portion of the basin is number 62-514-157. These three maps serve as index maps to the 15 land classification maps which show the areas classified. These maps are included in this appendix following the exhibits.

PRESENT IRRIGATION DEVELOPMENT

Data in table 2 indicate the general extent of irrigation within the Study Area during a recent period. Agricultural Census data provide additional information. The total acreage of irrigated cropland harvested[1/] in all counties or parishes lying partly or wholly in the Red River Basin, by states, for 1954 and 1959, is presented in table 3.

TABLE 3 - IRRIGATED CROPLAND HARVESTED: ACREAGE, BY STATES

Red River Basin Study Area

States	Irrigated Cropland Harvested	
	1954	1959
	(acres)	(acres)
Arkansas	4,668	5,059
Louisiana	90,922	63,795
Oklahoma	1,795	2,061
Texas	3,740	4,170
Totals	101,125	75,085

Source: U. S. Department of Commerce, Bureau of Census, Census of Agriculture (whole counties and parishes).

Census data shows that acreage of irrigation is increasing in Arkansas, Oklahoma, and Texas counties of the Study Area. Three projects which include irrigation as a purpose have been authorized in Louisiana under P.L. 566, as amended. The full impact of these has not yet been felt, but there is an increasing interest in supplemental irrigation in the state.

Irrigated Crops by States

An estimated 41,690 acres were irrigated in the Study Area for the years inventoried. An additional 33,780 acres had been previously irrigated. The predominant single crop irrigated was rice, which comprised over 60 percent of the irrigated area in Louisiana. Other major crops irrigated in the Red River Basin

1/ Irrigated cropland harvested as defined in the Census of Agriculture is "the data for irrigated cropland harvested relate to all irrigated land from which crops were harvested, regardless of the method of irrigation. It includes irrigated land from which hay was cut, irrigated land on both bearing and nonbearing fruit and nut crops, and irrigated land from which volunteer crops were harvested. Each irrigated acre was to be reported only once regardless of how many crops were harvested from it."

included cotton, corn alfalfa, and pasture. Table 4 shows acres irrigated by crops for the Study Area portion of Arkansas, Louisiana, Oklahoma, in 1963, and Texas, in 1964.

TABLE 4 - IRRIGATED ACREAGE BY CROPS*

Red River Basin Study Area

Crop	Arkansas	Louisiana	Oklahoma	Texas
Alfalfa	366	25	1,650	155
Cane	-	1,100	-	-
Corn	608	820	303	436
Cotton	2,600	5,352	1,315	1,650
Orchard	-	-	-	150
Pasture	825	1,035	518	1,773
Peanuts	-	-	557	1,039
Potatoes, Sweet	-	35	-	160
Small Grain	28	60	-	-
Sorghum, Forage	190	40	100	218
Sorghum, Grain	-	420	-	40
Soybeans	229	-	-	-
Vegetables	106	4	40	92
Other	-	-	80	230
Subtotal (excluding rice)	4,952	8,891	4,563	5,943
Rice	1,757	14,533	150	901
Total	6,709	23,424	4,713	6,844

*Source: Soil Conservation Service questionnaires and Texas Water Commission Bulletin 6515.

A summary of crops in the basin for which the entire acreage was irrigated during 1954 and 1959 is shown in exhibit 4. Corn, rice, hay crops, cotton, and vegetables were generally given priority in the use of irrigation during both census periods. In 1959, supplemental irrigation practices were extended to the peanut and soybean acreages increasing both acreages over previous 1954 data.

The total acreage of irrigated and nonirrigated crops for selected crops in the basin, and the percentage each crop was of the total selected crops irrigated are shown in exhibit 5. In 1954, about 40 percent of the selected irrigated acreage was planted to

cotton and about 27 percent to corn harvested for grain. In 1959, about 64 percent of the total selected acreage of crops irrigated was in cotton. Generally, the cotton crop was given priority in the use of the irrigation system throughout the Study Area.

Irrigation Water Sources

The sources of water used for irrigation of the above acreages are summarized in table 5 by states. The data are for water used in 1963 for Arkansas, Louisiana, and Oklahoma, and 1964 for Texas.

TABLE 5 - SOURCES OF WATER USED FOR IRRIGATION

Red River Basin Study Area

	Arkansas	Louisiana	Oklahoma	Texas	Total
Total Area Irrigated from Surface Water Only (ac)	1,317	13,339	4,400	4,189	23,245
Total Area Irrigated from Ground Water Only (ac)	4,842	9,765	313	744	15,664
Total Area Irrigated from Combined Supplies (ac)	550	320	0	1,911	2,781
Total Area Irrigated from Surface and Ground Water (ac)	6,709	23,424	4,713	6,844	41,690

Surface water is the primary source of irrigation in Oklahoma and Texas. In Arkansas, ground water is used primarily. While surface water is the primary source of use in Louisiana, the acreage irrigated from ground water in that state amounts to more than that in the other three states combined. Combined sources are used to a large extent in Texas.

Irrigation Facilities

The questionnaires submitted to SCS Work Units in Arkansas, Louisiana, and Oklahoma, and Texas Water Commission Bulletin 6515 reflected data relating to source of water and available irrigation

facilities which were summarized by states. This includes data relative to areas irrigated in 1963 for Arkansas, Louisiana, and Oklahoma, and 1964 in Texas. Information furnished by the questionnaires included the area irrigated by sprinkler method, number of sprinkler systems in the area, and number of irrigation wells in the area. These are summarized in table 6.

TABLE 6 - INVENTORY OF IRRIGATION FACILITIES BY STATES

Red River Basin Study Area

	Arkansas	Louisiana	Oklahoma	Texas	Total
Area Irrigated by Sprinkler Method (ac)	1,115	2,247	2,585	3,953	9,900
Sprinkler Systems in Area - number	52	51	68	85	256
Irrigation Wells in Area - number	90	61	7	53	211

Although the sprinkler method of irrigation has been used to the greatest extent in Texas, this method is of considerable importance in all four states. Irrigation wells are most numerous in Arkansas. Irrigation wells play a minor role in Oklahoma for supplying irrigation water.

WATER LAWS BY STATES

State laws relating to the use of water are described in appendix XIV. Existing laws are not a problem in developing the irrigation potential.

WATER QUALITY

During the time of the year when irrigation is needed, Red River water is not suitable for use on many of the soils in the Red River alluvium. Water of present quality can be used only on deep, medium to coarse textured, moderately rapidly permeable soils. Even on these soils, special management for salinity control is required.

The water of tributary streams of Red River below Denison Dam is generally better suited for irrigation purposes than main stem water. However, records show that the quality of surface waters in

the basin can be extremely variable. It appears that the quality of main stem water for irrigation could be improved by dilution with releases from proposed Corps of Engineers' tributary reservoirs.

Generally, the quality of ground water is good throughout the Study Area. Some aquifers in hill areas adjacent to the Red River alluvium in southeastern Oklahoma, and in Arkansas and Louisiana contain water that is unsuitable for sustained irrigation use; however, this is not a significant problem because the presently irrigated land is located principally in the alluvial land.

UNIT WATER REQUIREMENTS

Irrigation water requirements are variable, depending on several factors. Among those factors are land use, consumptive use of crops, soils, root zone depth, effective precipitation, application efficiency, and delivery system losses.

An example of maximum supply unit irrigation water requirements for typical Southern Mississippi Valley Alluvium LRA soils and crops is given in table 7.

TABLE 7 - IRRIGATION WATER REQUIREMENTS - 90 PERCENT CHANCE

Vicinity of Alexandria, Louisiana

Crop	Cotton	Cotton	Corn	Corn	Truck	Truck	Pasture	Pasture
Soil Unit	8	4	8	4	8	4	8	4
Net Irrigation (inch)[1/]	3.4	3.0	2.8	2.6	1.3	1.0	2.8	3.1
	(inches)							
April	-	-	.15	.32	2.00	2.34	.22	-
May	.80	1.35	1.52	1.75	2.78	3.00	1.52	1.20
June	3.92	4.20	4.30	4.46	5.32	5.60	4.30	4.13
July	4.60	4.60	4.60	4.60	4.86	5.00	4.60	4.60
August	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04
September	-	-	-	-	3.72	3.78	3.53	3.50
October	-	-	-	-	2.30	2.34	2.25	2.25
November	-	-	-	-	.20	.23	-	-
Total	14.36	15.19	15.61	11.57	26.22	27.33	21.46	20.72

1/Net amount of water to be applied per irrigation.

Requirements shown in the table are the maximum supplemental water needs by the crops nine out of ten years. "Drought and Water Surplus in Agricultural Soils of the Lower Mississippi Valley Area," Agricultural Research Service Technical Bulletin No. 1209, was used in determining these requirements. Requirements obtained using this bulletin were checked against the modified Blaney-Criddle method, which was used in SCS Technical Release No. 21. Results were comparable. The example area used is in the vicinity of Alexandria, Louisiana.

Application and delivery system losses must be added to the requirements shown in table 7. Normally 70-75 percent application efficiency can be expected. Delivery system efficiencies normally will vary between 75 and 85 percent, depending upon type of delivery system and distance between water supply and point of use.

Unit water requirements, as stated before, can vary widely. For estimating purposes, the values shown in table 8 are considered reasonable.

TABLE 8 - UNIT WATER REQUIREMENTS

State	Surface Water diversion requirements (feet per acre)	
	Average Annual	Maximum supplemental requirement in 9 out of 10 years
Arkansas	2.00	2.75
Louisiana	1.75	2.50
Oklahoma	2.25	3.00
Texas	2.25	3.00

These requirements are based on cropping systems generally used in the Study Area. The average annual diversion requirements are liberal to allow for future crop distribution changes, low water use efficiencies, and for the indeterminate losses due to the use of bayou systems for the delivery of irrigation water.

POTENTIAL IRRIGATION DEVELOPMENT

WATER AVAILABILITY

Average annual runoff in the Study Area ranges from 7 inches in Grayson County, Texas, to 20 inches in Polk County, Arkansas. At the Shreveport Red River gage, for a 36-year period ending in 1964, the average annual runoff was approximately 18 million acre-feet per year or 16 billion gallons per day. For the same period at the Alexandria Red River gage, the average annual runoff was approximately 23 million acre-feet per year or 20 billion gallons per day. Table 9 shows maximum and minimum monthly flows for the crop growing season at selected gaging stations. The historical period begins in April 1945, which is the first month after Denison Reservoir was placed in full operation.

TABLE 9 - MONTHLY RED RIVER FLOWS

Month	GAGE									
	Colbert, Oklahoma 1945-1961		Arthur City, Texas 1945-1962		Index, Arkansas 1945-1962		Shreveport, Louisiana 1945-1960		Alexandria, Louisiana 1945-1960	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	1000 acre-feet									
March	292	44	561	160	1,141	207	3,749	494	5,343	696
April	1,214	65	2,290	80	3,295	125	9,161	330	11,800	944
May	2,134	44	3,885	183	5,381	348	9,520	867	9,995	1,243
June	3,984	86	4,988	123	5,617	189	8,296	312	9,021	384
July	1,220	97	1,626	98	1,895	106	2,740	137	3,523	187
August	1,572	85	2,142	87	2,412	101	3,350	109	3,257	144
September	614	85	1,131	87	1,806	88	3,677	89	3,620	110
October	1,683	4	2,196	16	2,564	44	3,469	68	3,638	98
November	550	5	1,320	14	2,022	38	4,045	81	5,344	97

Water requirements were calculated for each state for the months of July and August. July is the month of peak requirement for each state except Louisiana, but when considered with the other three states, the total water requirement for July is larger. Water requirements were compared with the 90 percent chance minimum Red River Flows and July was found to be the critical month. Therefore, July was used for calculation of all peak water requirements.

Table 10 shows daily and monthly Red River flows which will be equaled or exceeded on the average, nine out of ten years during the month of July. Values for each station, except Fulton, are based on the same period of record as shown in table 9. The Fulton, Arkansas,

values are based on the period 1949-1960. Table 10 figures represent flows that are available for all purposes.

TABLE 10 - JULY RED RIVER FLOWS

(90 Percent Chance of Occurrence)

Gage	Minimum Daily Discharge (c.f.s.)	Monthly Flow (1,000 Acre-Feet)
Colbert, Oklahoma	100	141
Arthur City, Texas	1,050	178
Index, Arkansas	1,700	215
Fulton, Arkansas	1,900	255
Shreveport, Louisiana	2,800	320
Alexandria, Louisiana	4,700	350

Several large multiple-purpose reservoirs are either authorized or under construction. Releases from these reservoirs are expected to increase average discharges during periods of low flow; particularly, the months of September and October. Less significant discharge increases are expected for July, the peak irrigation water use month.

Table 11 shows estimates of minimum monthly flows at selected stations along Red River.

TABLE 11 - MINIMUM MONTHLY FLOWS - RED RIVER

Station	Unregulated			Regulated		
	c.f.s.		AF/DAY	c.f.s.		AF/DAY
Denison, Texas	(1)	67	133	(2)	67	133
Fulton, Arkansas	(1)	790	1,566	(3)	2,860	5,670
Shreveport, La.	(1)	1,110	2,200	(3)	3,000	5,950

(1)Regulation by Denison Dam only.
(2)Flows modified by all existing and authorized reservoirs.
(3)Flows estimated by routing critical drought period.

Studies of upstream watershed areas show that many tributary streams have a potential for development of high quality irrigation water storage in reservoirs. Several reservoir sites are being developed in Louisiana under P.L. 566 for irrigation water storage

and other purposes. Reservoir sites have been located for all of the potential irrigation development in watersheds in which construction is expected to be initiated within the next 10-15 years. Opportunities for developing other reservoir sites for irrigation water storage are available throughout the Study Area. Specific sites have not been identified for irrigation water storage for project-type irrigation development that is included beyond the 10-15 year project category.

The greatest potential for ground water development in the Study Area is in the alluvial deposits that underlie the floodplain of Red River. Wells in the alluvium yield up to 500 g.p.m. (gallons per minute) in Texas and Oklahoma, 1,000 g.p.m. in Arkansas, and 1,700 g.p.m. in Louisiana. Well depths range from less than 500 feet near Denison Dam to about 150 feet in the lower reach of the Study Area.

The tributary basins also have potentials for ground water development; however, in these areas well depths are generally greater, and yields are more variable.

Large supplies of ground water are available in parts of the Sulphur River and Cypress Creek Tributary Basins. The greatest potential for ground water development is in the southeastern part of this area, which is underlain by thick water-bearing sand formations. These strata may yield as much as 50 g.p.m. to wells that range from 100 to 300 feet in depth. Supplies of ground water also are available at depths below 1,200 feet in the northwestern part of this area; however, because of the greater depth to the water, the potential for development is low. Large supplies of water are available from alluvial deposits in the lower reaches of these tributary basins. The depth of wells in the alluvium is less than 150 feet, and the yield may be as much as 1,700 g.p.m.

Large supplies of ground water are available for development in only a few parts of the Blue, Muddy Boggy, Kiamichi, and Little River Tributary Basins. The greatest potential lies in the lower reaches which are underlain by thick, sedimentary deposits of the Southern Coastal Plain. These strata may yield from 50 to 500 g.p.m. from depths less than 150 feet; wells deeper than 150 feet yield from 50 to more than 150 g.p.m. Limestone formations on Upper Blue River yield water to springs and wells from fractures and solution channels. Wells yield as much as 50 g.p.m. locally from shallow depths, but the strata may be barren of water at other locations because of the lack of openings in the rock. The sandstone and shales that underlie most of the upper drainage areas are capable of producing only 10 to 15 g.p.m. intermittently to wells less than 25 feet deep.

Moderate to large quantities of ground water are available nearly everywhere in the tributary basins on the east side of Red River in Arkansas and Louisiana. Wells in these areas range from 100 to 300

feet deep in most places, but are as much as 1,500 feet deep near Hope, Arkansas. The maximum yield generally ranges from 300 to 500 g.p.m.; however, wells may yield as much as 1,500 g.p.m. in Columbia and Lafayette Counties, Arkansas, and Webster, Claiborne, Bienville, Natchitoches, Winn, and eastern Bossier Parishes, Louisiana.

Moderate to large supplies of ground water are available in the tributary basins on the west side of Red River in Louisiana, except for a small, nonproductive area in Sabine and Natchitoches Parishes. Wells in the upland area of Caddo, DeSoto, Natchitoches, Sabine, and northwestern Rapides Parishes range from 300 to 400 feet in depth and yield as much as 500 g.p.m. In Central Rapides Parish, wells range from 600 to 1,500 feet in depth and yield up to 1,200 g.p.m.

The location and availability of the ground water resources are discussed in detail in appendix III, "Hydrology, Surface and Ground Water, and Geology, for the Red River Comprehensive Study."

ECONOMIC FACTORS

To evaluate the economic feasibility of irrigation, it is necessary to have both costs and returns from irrigation. Crop production information for Arkansas was not available from the 1959 Census of Agriculture. Other secondary sources were utilized for determining the crop yields relating to the Arkansas portion of the Red River Basin.

Because cotton, soybeans, corn for grain, alfalfa, and tame pasture (or other hay) utilized most of the irrigation system, only these crops are included in this analysis. Production inputs and outputs on irrigated vegetables were not developed.

In addition to irrigation, other management and cultural practices are likely to affect crop yields. However, since both irrigated and nonirrigated crops, of these selected crops, are produced in the Red River Basin bottomlands under the same general system of management, yield differences reported by Census and Crop Reporting Service for irrigated and nonirrigated crops were used to evaluate irrigation.

Production practices of irrigated and nonirrigated crops influence the amount of inputs required to gain any increase in yields. From a study of secondary sources, it was indicated that additional choppings are required on irrigated cotton. Hoe labor is used to control weeds during the latter part of the growing season when cotton gets too large to cultivate. Apparently, irrigation encourages the growth of weeds which interferes with machine harvest.

Except for the practices associated with irrigation, there was little difference in production practices employed in producing soybeans, corn, alfalfa and other hay crops, or tame pasture. Variations in production practices are generally associated with the rate of application for fertilizer and insecticides, or chemicals for the control of weeds.

Studies indicate that benefits from supplemental irrigation of selected agricultural enterprises will justify a reasonable cost for providing a water supply. Supplemental irrigation is most prevalent in the Southern Mississippi Valley Alluvium LRA (figure 2). Suitable soils occurring in larger tracts, their high productivity, and availability to water, make them more feasible for irrigation. Supplemental irrigation has been used to a lesser degree in Southern Mississippi Valley Silty Uplands LRA and other land resource areas.

Feasibility of irrigation is usually limited to higher value crops. According to experiment station data, response of common Bermuda grass and other pastures to irrigation would not justify widespread use of irrigation for pastures alone. Although increased net returns from pastures are low, supplemental irrigation of pasture can be practiced as a secondary use of irrigation equipment after peak demands for other crops have passed.

Although a substantial acreage of rice has been grown with irrigation in the Red River Basin, primarily in Louisiana (table 4), the question of economic feasibility has been concerned with supplemental irrigation of crops other than rice. The acreage of rice planted is regulated by crop allotments controls and is not expected to change materially except by changes in legislation.

Economic feasibility of irrigation for selected crops was determined by the Economic Research Service. The estimated average yields per acre under good management, for irrigated and nonirrigated crops in the Red River Basin for the Southern Mississippi Valley Alluvium LRA are shown in table 12.

TABLE 12 - CROP YIELDS: SELECTED CROPS, IRRIGATED AND NONIRRIGATED, BOTTOMLAND SOILS, GOOD MANAGEMENT

Red River Basin Study Area

Crop and Unit of Production	Irrigated	Nonirrigated	Increase due to Irrigation
Cotton, lbs.	690	535	155
Corn, bu.	46	31	15
Soybeans, bu.	31	23	8
Alfalfa, ton	4	2.1	1.9
Other hay, or tame pastures, AUM	11	7	4

Although the response of crops to irrigation is expected to vary with adequately distributed rainfall throughout the growing season, the difference in yield between irrigated and nonirrigated crops experienced by farmers is used for purposes in evaluating irrigation of these selected crops. Also, irrigation may prove to be very profitable for some specialty crops, such as fruits and vegetables.

Adjusted normalized costs and returns from irrigation for the individual selected crops are presented in exhibits 6 through 10. A tabulation of adjusted normalized prices for specific commodities, for Arkansas, Louisiana, Oklahoma, Texas, and the four-state averages, is shown in exhibit 11. Using the variable inputs, labor requirements, and the expected outputs for irrigated crops, a return above specific costs was determined for each nonirrigated crop and summarized in exhibit 13.

The difference between the irrigated crop return and the nonirrigated crop return represents the amount available per acre for irrigation installation costs, annual operation and maintenance costs, increased interest on investment, and increased fixed cost (exhibit 14). This analysis indicates the increase which could be expected in returns per acre from cotton is $17.21; corn $5.31; soybeans $5.72; alfalfa $33.50; and hay crops, or tame pastures harvested for hay approximately $6.53.

Because of the vagaries of weather in the Study Area, farm operators who invest in irrigation systems will not receive returns on their investment each year it is owned. Irrigation of some crops in the basin would increase returns a substantial amount due to increased yields. This condition existed during the dry years of 1952 to 1956. However, there have been years in which the application of supplemental water would not have been profitable. Extreme

wet conditions developed during the growing season, and caused a decrease in returns compared to nonirrigated conditions.

With increased knowledge regarding the amounts and placement of fertilizers, seed varieties, cultural practices, and other variables associated with crop production, the control of plant moisture requirements will become more critical. Based upon the estimated increased returns by this study, the added returns from cotton and alfalfa may be sufficient to cover the added cost of providing the irrigation system. The added returns from soybeans, corn, and hay crops, or tame pastures, would require an analysis of the various types of irrigation systems. Individual situations and local areas would have to be appraised on the basis of comparability of this analysis.

FUTURE NEEDS FOR IRRIGATION DEVELOPMENT

It has been determined that project-type irrigation development is not a prerequisite in order to meet production requirements in the near future. These can be met by advanced technology used on available land resources without the aid of irrigation development.

Although studies indicate that national needs to not justify proposing large areas for irrigation, other factors are involved. Many farmers have installed irrigation equipment to increase their yields and to provide crop insurance. The twin incentives of increased income and insured income will continue to encourage individuals and groups of individuals to place more land under irrigation. Demands for quality control in vegetables, fruits, and specialty crops will increase irrigation development. With agriculture becoming increasingly competitive, it is anticipated that a real potential for increased irrigation exists in the Study Area.

APPRAISAL OF POTENTIAL DEVELOPMENT

In the final analysis, the appraisal of potential irrigation development must be a judgment figure based on the best data available. Supplemental irrigation is not expected to influence overall cropping distribution in the Red River Basin to any significant degree. Currently irrigated land represents a small portion of the potentially irrigable land. Irrigated land, as determined from questionnaires summarized in table 2, is equivalent to about two percent of the area classed as similar to irrigated soils. Of the more than two million acres which are similar to irrigated soils, most of those, which are other than alluvial, have little potential for irrigation because of high development costs for water supplies and land preparation.

The Soil Conservation Service Irrigation Guide data indicated that about 6,188,000 acres (exhibit 1) of the Study Area had soils

physically suitable for irrigation. The questionnaire survey showed that most of the present irrigation is practiced on the Southern Mississippi Valley Alluvium LRA and it seems likely that this resource area has the greatest potential for the future development of irrigation. The 1958 inventoried acreages of this LRA suited for irrigation are summarized by state and land use in table 13.

TABLE 13 - SOILS SUITABLE FOR IRRIGATION - SOUTHERN MISSISSIPPI VALLEY ALLUVIUM LRA

Red River Basin Study Area

States	Cropland	Pasture Range	Forest Woodland	Other	Total
	(acres)	(acres)	(acres)	(acres)	(acres)
Arkansas	128,777	51,113	106,056	0	285,946
Louisiana	445,807	299,866	292,590	41,252	1,079,515
Oklahoma	62,511	34,633	24,670	0	121,814
Texas	69,906	27,440	46,304	0	143,550
Total	706,901	413,052	469,620	41,252	1,630,825

Source: Conservation Needs Inventory

The acreages shown in table 13 as cropland and pasture range are especially significant because it is in these land use divisions that most of the potential exists. While a portion of the forested woodland may have soils and topography suitable for irrigation, the costs of clearing and preparing the land for irrigation usually make the lands uneconomical to develop at this time. However, woodland clearing has been proceeding rapidly in recent years and this trend is expected to continue. Consequently, must of the acreage shown as woodland in table 13 will be converted to crop and pasture use in the future. These anticipated land use changes will provide opportunities for future irrigation of land that is presently in woodland use. Similarly, a portion of the crop and pasture lands has limiting factors, such as availability of an adequate water supply, flood hazards, lack of adequate drainage, and other restrictive problems.

The Bureau of Reclamation surveys are generally indicative of the magnitude of project-type irrigation for which there is a reasonable chance for development. Their surveys indicate a total of about 317,000 acres of these lands. To that area should be added the potential for individual irrigation which can develop on areas too small or too isolated to be considered for project-type irrigation.

Thus, the extent of future irrigation logically should fall between the 317,000 acres designated by the Bureau of Reclamation and the 2,146,000 acres estimated from questionnaire data. A final figure for Oklahoma and Texas was decided by consultation among various members of the Irrigation Work Group.

Estimates of the amount of the potential irrigation development were selected in consultation with the Oklahoma Water Resources Board. In Oklahoma, the estimated extent of future irrigation is placed at 156,000 acres. Of this amount, 50,000 acres are anticipated as project-type developments, while the remaining 106,000 acres would be private developments.

Acreages for the Texas portion of the Study Area were developed in consultation with the Texas Water Development Board. The area estimated for future irrigation in that state is 99,600 acres. Of that amount, 20,000 acres could be project-type and the remaining 79,600 acres would be developed individually.

Estimates for the Arkansas and Louisiana portion of the basin were prepared jointly by the Bureau of Reclamation and the Soil Conservation Service. Bureau of Reclamation surveys indicated that there are about 86,000 acres of bottomland in Arkansas suitable for project-type irrigation. After consideration of the various problems, it was decided to expand the area by 24,000 acres to allow for private development of small, scattered tracts. The total area for Arkansas is 110,000 acres. No project-type areas were identified for immediate construction.

Louisiana has the greatest area currently irrigated and has a greater potential for irrigation development than any of the other states. Although the climatic conditions are such that the need to irrigate is the least, other considerations make irrigation attractive. Bureau of Reclamation studies showed a total of about 161,000 acres of bottomland suitable for project-type development. After careful consideration of the problems and conditions, an allowance of 239,000 acres including rice production areas was made to provide for private development, making a total of 400,000 acres for the State of Louisiana. Of the 161,000 acres, about 57,500 acres have been identified as project-type developments within the next 10-15 years. Of the total of 400,000 acres with potential for irrigation development, 200,000 acres are considered irrigable under present land use conditions, while the other 200,000 acres will require clearing, flood protection, and additional drainage measures before they can be irrigated.

The estimated area for future irrigation developments, by states, is summarized in table 14.

TABLE 14 - POTENTIAL FUTURE DEVELOPMENT

Red River Basin Study Area

State	Project-Type	Individual Type	Total
	Acres		
Arkansas	86,000	24,000	110,000
Louisiana	161,000	239,000	400,000
Oklahoma	50,000	106,000	156,000
Texas	20,000	79,600	99,600
Total	317,000	448,600	765,600

A complete distribution of the potential irrigation development by states and tributary basins for the intermediate years 1980 and 2030 and for 2080 is shown in exhibit 15. These acreages will provide guides for establishing the magnitude of water supplies needed to meet future irrigation demands.

Project-Type

Project-type potential development was identified to separate projects on which construction needs to be initiated within the next 10-15 years and projects that can be delayed. Three P.L. 566 watershed work plans have been developed for watersheds in the 10-15 year category. Irrigation is included as one purpose in each of these multiple-purpose development plans.

Acreages planned for irrigation in the three watersheds are Bayou Rapides, 10,524 acres; Cypress-Black Bayou, 8,400 acres; and Bayou Boeuf, 20,467 acres. Other project-type irrigation developments include 3,060 acres in Johnson Chute Watershed and 15,040 acres in Cane River Tributary Basin. Total acreage is 57,491 acres in these watersheds in which construction is expected to be initiated within the next 10-15 years.

Project-type irrigation in P.L. 566 watershed plans has been confined to soil units 4 and 8. Soil unit 3, due to its characteristics, is best adapted to supplemental irrigation when the land use is pasture. Although soil unit 2 can be adapted to irrigation, available water supply is usually a limiting factor for irrigation of these soils.

Watersheds considered potentially feasible for development and initiation of construction within 10-15 years, which include

irrigation as a purpose, are confined to projects in Louisiana. These are located in tributary basins as follows:

Tributary Basin	Conservation Needs Inventory Watershed and Number
Loggy Bayou	Cypress-Black Bayou - 3m2-3
Chatlin Lake and Associated Area	Bayou Boeuf - 10-15
Bayou Jean de Jean and Bayou Rapides	Bayou Rapides - 10-17
Bayou Pierre	Johnson Chute - 3n-2
Cane River	Cane River - 3-64, 3-65, 3-66

Projections of existing and potential developments considered projects in the 10-15 year category in place by 1980. All other project-type areas, totaling 259,500 acres, were assumed to be developed at a uniform rate between 1980 and 2080. The total anticipated developments in areas not in the 10-15 year category were assumed to be at a uniform rate from present to 2080.

Individual Development

Irrigation development by individuals is expected to continue. Of the total area projected for potential development, that which is not classified as project-type would be by individual development. Future development is expected to occur at a generally uniform rate from the present to 2080, except where influenced by projects.

WATER RESOURCES FOR POTENTIAL DEVELOPMENT

WATER QUANTITY AND QUALITY REQUIREMENTS

Water quantity requirements are based upon existing and potential irrigation development needs in the Study Area. All requirements were calculated to provide for maximum supplemental water crop needs nine out of ten years. All gross water requirements are based on present and future acreages for irrigation development and maximum water diversion requirements given in table 8. Existing and future maximum gross water requirements are shown by states and type of irrigation in table 15.

TABLE 15 - EXISTING AND FUTURE GROSS WATER REQUIREMENTS IN ACRE-FEET BY STATES AND TYPE OF IRRIGATION

Red River Basin Study Area

State	Existing	1980 Project-Type	1980 Individual Type	2030 Project-Type	2030 Individual Type	2080 Project-Type	2080 Individual Type
Arkansas	18,400	0	56,100	118,300	60,500	236,500	66,000
Louisiana	58,500	134,200	130,000	263,500	363,000	392,900	597,500
Oklahoma	14,100	0	72,000	75,000	195,000	150,000	318,000
Texas	20,400	0	55,200	30,000	147,000	60,000	238,800
Total	111,400	134,200	313,300	486,800	765,500	839,400	1,220,300

All of the existing water requirements are developed and used by individual farmers. Future water requirements will be divided among project-type and individual-type water users. The anticipated requirement to supply all users in the year 1980 is 447,500 acre-feet. Of this amount, about 134,200 acre-feet will be project-type development in Louisiana for five projects identified for initiation of construction within the next 10-15 years.

Bayou Rapides, Cypress-Black Bayou, and Bayou Boeuf Watersheds are authorized P.L. 566 projects in Louisiana and are in varying stages of completion. Water requirements for these three watersheds are 89,100 acre-feet. Johnson Chute and Cane River Watersheds were identified during the Red River Basin Study as having a potential for project development within the next 10-15 years. These two projects represent a requirement of 45,100 acre-feet. Water requirements for the three authorized P.L. 566 projects were obtained from the watershed work plans. Water requirements for Johnson Chute and Cane River Watersheds were developed during preliminary investigation scope studies.

The maximum gross water requirements for 1980, 2030, and 2080 do not include an allowance for return flows. It is estimated that one-third of diverted surface water would be returned as streamflow.

Irrigation water storage and delivery systems would be designed to provide an adequate water supply to meet maximum water requirements. However, maximum water requirements would not be needed each year. Average annual equivalent gross water requirements may be computed for comparison with maximum gross water requirements. Average annual project-type water requirements for

the years 1980, 2030, and 2080 are 100,600 acre-feet, 754,600 acre-feet, and 1,279,500 acre-feet, respectively.

Irrigation development is restricted within the Red River alluvial soils of the Study Area because water quality is unsatisfactory. Only 200,000 acres of the irrigable land can be safely irrigated with present quality Red River water. Even so, these soils may require salinity control practices for sustained production. Crop growth, however, may be related more closely to factors other than water quality. For instance, saline waters may be used satisfactorily to irrigate salt tolerant crops on coarse textured soils where rainfall is sufficient to permit leaching in the root zone. Under similar conditions, a poorly drained soil might cease to produce. Type of crop, type of soil, and rainfall are some factors that determine whether water of a given quality can be used successfully for irrigation purposes.

According to USDA Handbook No. 60, criteria used to classify quality of water for irrigation purposes are: (1) total concentration of soluble salts; (2) relative proportion of sodium to other cations; (3) concentration of boron or other elements that may be toxic; and (4) under some conditions, the bicarbonate concentration as related to the concentration of calcium plus magnesium. Figure 3 was developed by the U. S. Salinity Laboratory Staff and may be used to classify irrigation water according to the alkali and salinity hazard.

Red River water quality data, table 16, were taken from U. S. Geological Survey published reports.

TABLE 16 - RED RIVER WATER QUALITY

Month	GAGE					
	Denison Dam, Okla. 1951-1957		Shreveport, La. 1955-1957		Alexandria, La. 1953-1957	
	Sodium Adsorption Ratio (SAR)	Specific Conductance (Micromhos at 25°C.)	Sodium Adsorption Ratio (SAR)	Specific Conductance (Micromhos at 25°C.)	Sodium Adsorption Ratio (SAR)	Specific Conductance (Micromhos at 25°C.)
March	4.6	1,650	2.2	566	2.0	438
April	4.6	1,647	1.5	453	1.7	397
May	4.4	1,560	1.8	513	1.4	380
June	4.2	1,495	2.0	627	2.1	597
July	4.5	1,592	3.3	1,096	2.8	955
August	4.7	1,637	3.6	1,233	2.9	966
September	4.6	1,627	3.8	1,330	3.2	1,136
October	4.8	1,632	4.2	1,472	3.3	1,204
November	4.8	1,647	3.8	1,271	3.1	1,092

Table 16 data may be used in conjunction with figure 3 to classify irrigation water according to alkali and salinity hazard. A classification of table 16 values shows that the majority fall into the C3-S1 classification. In general, waters with conductivity values below 750 micromhos/cm. are satisfactory for irrigation insofar as salt content is concerned. It appears that the quality of Red River water for irrigation could be improved by dilution from water releases from large tributary reservoirs.

Generally, water of tributary streams is better suited for irrigation than Red River water. However, records show that quality of surface waters in the study area can be extremely variable. Sometimes, brine seepage from oilfields causes, locally, high concentrations.

Boron, bicarbonate, residual sodium bicarbonate, or other toxic elements affecting the quality of irrigation waters are not present in sufficient quantities to be considered a potential hazard.

Usually, the salt content of return irrigation water will be higher than that of the water before application because evaporation and transpiration processes tend to increase the concentration of dissolved salts. Agricultural chemicals and soil erosion further degrade the water quality by their pollution effects. The turbidity resulting from irrigation appears to be minor, but most agricultural chemicals are extremely toxic to aquatic life and constitute a potential hazard to humans. Therefore, routes by which return flows enter surface streams should be thoroughly investigated and evaluated.

WATER SUPPLY COSTS

Water supply costs vary widely depending upon source of water and complexity of development of water supply.

The cost of pumping water from the river averages $0.05 per acre-foot per foot of lift. The cost of pumping water from underground sources is approximately $0.075 per acre-foot per foot of lift. These are based on amortized installation costs along with annual operation and maintenance.

Based on data from Soil Conservation Service watershed work plans, the installation cost of reservoirs for irrigation water storage varies from approximately $200 to $500 per acre of land to be irrigated. Installation cost of delivery systems may vary between approximately $30 and $100 per acre of land to be irrigated. On-farm costs associated with irrigation are approximately $100 to $150 per acre of land to be irrigated.

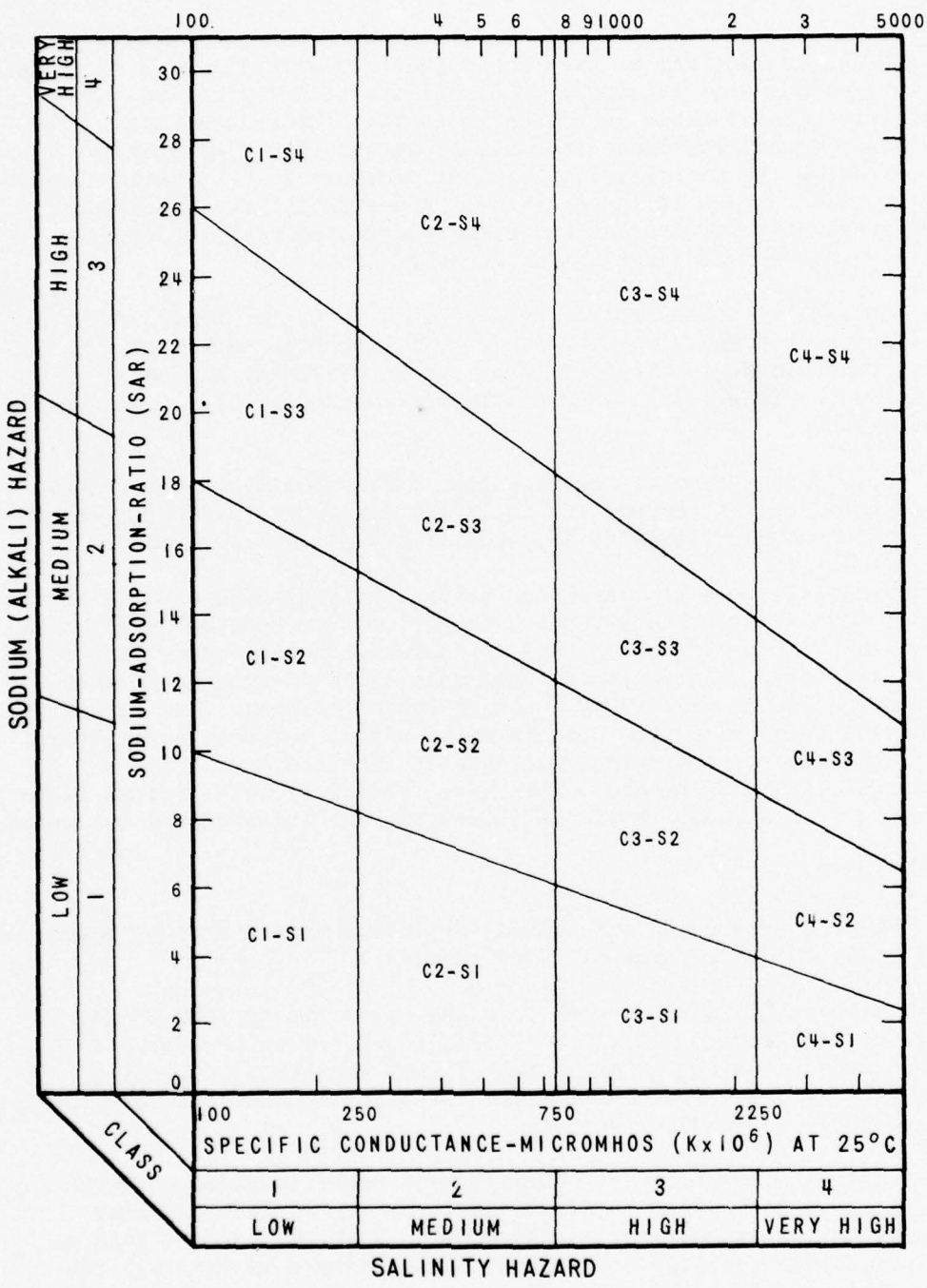


Figure 3

CLASSIFICATION OF IRRIGATION WATERS

Source: "Diagnosis and Improvement of Saline and Alkali Soils"
U. S. Department of Agriculture Handbook No. 60, 1954

4-64 4-L-18746

4-19337 10-64

The annual equivalents of estimated installation costs amortized for 100 years at 3 1/8 percent interest range from $6 to $16 per acre to be irrigated for storage of water supply for P.L. 566 projects. The annual equivalent of estimated costs for delivery systems determined on the same basis vary from $1 to $3 per acre to be irrigated, depending on distance and other factors. Annual operation and maintenance costs of these structural measures are not included in the above estimates.

Bureau of Reclamation investigations indicate that the cost of gravity irrigation systems capable of delivering water to the individual farms in the project area, including pumping plant facilities to divert water from the stream supply, would range from $300 to $500 per acre. These costs include project drainage facilities to remove excess water. Annual operation and maintenance costs would range from $7 to $9 per acre. On-farm land development costs associated with irrigation range from $50 to $200 per acre according to the land classification standards used for the investigation.

The annual equivalent value of capital investment costs, such as land leveling and on-farm irrigation systems, amortized over their economic life, along with their operation and maintenance, are costs associated with irrigation which must be deducted from increased returns from irrigated crop enterprises.

Increased expenditures for such things as labor, fertilizer, etc., normally incurred in irrigation farming are included as production costs with irrigation.

ADEQUACY OF WATER SUPPLY

Stream records at the Alexandria gage indicate that the average annual Red River flow is approximately 23 million acre-feet. Estimates of future irrigated land are not expected to exceed 765,600 acres. Based on gross water requirements estimates in table 15, not more than 839,400 acre-feet of water would be needed to satisfy future project-type irrigation requirements within the Study Area during the year of greatest irrigation water need.

The adequacy of the water supply for irrigation purposes must take into consideration both ground water and surface water sources. The annual runoff volume of Red River, 23 million acre-feet, appears to satisfy all water needs. However, low flows in Red River, if water quality were good, would not be sufficient to meet peak withdrawal rates needed during the irrigation period. Adequate quantities of water for irrigation use would be available if provisions for water storage are made.

As stated in appendix III, ground water aquifers in the Study Area are potentially capable of producing an estimated aggregate of 800 million gallons of water per day. However, additional areal investigations and specific site studies will be necessary to determine the exact available yields. The development of ground water supplies for irrigation will be governed by depths to the water and dependable annual yields at points of need.

As discussed under water quantity requirements, existing requirements for irrigation water are 111,400 acre-feet. Approximately 60 percent of this is being obtained from surface water sources and 40 percent from ground water sources. The quantity obtained from surface water and ground water sources varies from 90 percent and 10 percent, respectively, in Oklahoma to 25 percent and 75 percent, respectively, in Arkansas.

All water requirements (134,200 acre-feet) for the five potential projects identified for initiation of construction in the next 10-15 years will come from reservoir storage. The source of water for the remaining potential requirements (1,925,500 acre-feet) will depend upon the type of development and the cost of development. It can be assumed that all project-type development will obtain water from surface water sources. The ratio of surface water to ground water for individual development is expected to become larger, because of the increasing difficulty and expense in obtaining water from ground water sources.

It can be concluded that there is a sufficient amount of water available for irrigation of the 765,600 acres of present and potentially irrigable land. Suitable reservoir sites for storage of irrigation water are available throughout the basin. Some of these reservoirs may need to be located several miles from the area of use. Substantial amounts of ground water can be expected to be used for individual irrigation development. Increasing amounts can be expected to be obtained from Red River, especially if the quality of Red River water is improved.

In most cases, surface water quality of tributary streams is satisfactory for irrigation. USGS reports indicate that, generally, waters of the Sulphur, Cypress, Little River, Blue, Muddy Boggy, Kiamichi, and Clear Boggy Rivers are suitable for irrigation. Available records show that Loggy Bayou waters are marginally suited because of salinity.

In the reaches of Red River above Denison Dam, the Corps of Engineers is recommending measures to control major sources of natural salt pollution which render the river unfit for most uses. Survey reports regarding the study indicate that proposed remedial measures will reduce salinity concentrations below Denison Dam. Also, that improved quality will be acceptable for municipal, industrial, and agricultural water uses.

The quality of the water is suitable for irrigation from practically all of the principal aquifers in the Study Area in Texas that have a potential for irrigation development.

In general, good quality ground water is available in the Study Area in Oklahoma and Arkansas except in upland areas adjacent to the Red River alluvium in McCurtain County, Oklahoma, and Little River, Hempstead, Nevada, and Lafayette Counties, Arkansas, where the ground water is highly saline.

In the Louisiana portion of the Study Area, the ground water generally is suitable for irrigation except for upland areas adjacent to both sides of the Red River alluvium and in a few isolated areas in the Red River flood plain.

More detailed information on the suitability of water for irrigation is presented in appendix III.

Exhibit 1 - Soils Suitable for Irrigation by Tributary Basins, Red River Basin Study Area

Tributary Basin	Arkansas	Louisiana	Oklahoma	Texas	Total
	(Acres)				
Barkman Creek	-	-	-	21,400	21,400
Bayou Jean de Jean	-	16,000	-	-	16,000
Bayou Pierre	-	440,000	-	90	440,090
Bayou Rapides	-	38,000	-	-	38,000
Bayou Rigolette	-	82,400	-	-	82,400
Black & Saline Lakes	-	399,600	-	-	399,600
Blue River	-	-	103,200	-	103,200
Boggy Creek	-	-	271,300	-	271,300
Bois d'Arc Creek	54,000	-	-	-	54,000
Cane River	-	189,650	-	-	189,650
Chatlin Lake	-	322,400	-	-	322,400
Cypress Creek	26,010	204,420	-	374,360	604,790
Kiamichi River	-	-	77,900	-	77,900
Little River	270,100	-	150,900	-	421,000
Loggy Bayou	205,100	419,000	-	-	624,100
Maniece Bayou	57,000	-	-	-	57,000
McKinney Bayou	145,850	-	-	10,550	156,400
Intervening Areas - Ark. & Okla.	81,900	-	231,050	-	312,950
Intervening Areas -- Texas	-	-	-	708,500	708,500
Nantachie Creek	-	14,560	-	-	14,560
Posten Bayou	41,580	17,420	-	-	59,000
Red River Backwater	-	191,300	-	-	191,300
Red River Main Stem	-	142,250	-	-	142,250
Sulphur River	64,500	-	-	815,400	879,900
Total	946,040	2,477,000	834,350	1,930,300	6,187,690

Source: USDA National Inventory of Soil and Water Conservation Needs, 1958, and Soil Conservation Service irrigation guides.

Exhibit 2 - Inventory of Irrigated and Similar Soils by Counties and Parishes[1/]

County	Total Area Irrigated in 1963	Total Area Previously Irrigated but not in 1963	Additional Area Similar to Irrigated Soils	Total Irrigated & Similar Soils
	(Acres)			
ARKANSAS				
Columbia	500	200	3,000	3,700
Hempstead	0	0	0	0
Howard	0	600	5,000	5,600
Lafayette	3,354	1,000	6,000	10,354
Little River	712	1,202	190,000	191,914
Miller	2,015	400	120,000	122,415
Nevada	50	50	85,000	85,100
Polk	8	120	20,000	20,128
Sevier	70	120	1,500	1,690
Total - Arkansas	6,709	3,692	430,500	440,901
LOUISIANA				
Avoyelles	15,580	0	139,660	155,240
Bienville	120	0	0	120
Bossier	970	2,320	50,000	53,290
Caddo	1,220	140	147,000	148,360
Catahoula	780	300	85,000	86,080
Claiborne	30	0	28,000	28,030
DeSoto	60	20	1,353	1,433
Evangeline	0	0	0	0
Grant	170	200	12,000	12,370
LaSalle	0	0	0	0
Lincoln	0	0	0	0
Natchitoches	2,325	600	204,386	207,311
Rapides	2,040	0	42,000	44,040
Red River	0	935	195,787	196,722
Sabine	0	0	0	0
St. Landry	0	0	0	0
Vernon	0	0	0	0
Webster	129	167	7,400	7,696
Winn	0	0	0	0
Total - Louisiana	23,424	4,682	912,586	940,692

Exhibit 2 - Inventory of Irrigated and Similar Soils
by Counties and Parishes[1/] (cont'd)

County	Total Area Irrigated in 1963	Total Area Previously Irrigated but not in 1963	Additional Area Similar to Irrigated Soils	Total Irrigated & Similar Soils
	(Acres)			
OKLAHOMA				
Atoka	170	0	0	170
Bryan	3,295	730	65,000	69,025
Choctaw	500	4,000	50,000	54,500
Coal	118	240	15,000	15,358
Hughes	0	0	0	0
Johnson	300	160	3,000	3,460
Latimer	10	10	3,000	3,020
LeFlore	0	0	0	0
McCurtain	300	870	13,000	14,170
Murray	0	0	0	0
Pittsburg	0	0	6,000	6,000
Pantotoc	20	0	2,500	2,520
Pushmataha	0	0	0	0
Total - Oklahoma	4,713	6,010	157,500	168,223
TEXAS*				
Bowie	2,886	13,949	111,900	128,735
Camp	340	2	6,000	6,342
Cass	130	32	8,000	8,162
Delta	0	0	31,500	31,500
Fannin	1,780	1,302	93,180	96,262
Franklin	0	45	21,500	21,545
Grayson	150	180	12,100	12,430
Gregg	0	167	1,000	1,167
Harrison	0	254	2,000	2,254
Hopkins	155	110	43,000	43,265
Hunt	0	0	0	0
Lamar	300	728	87,800	88,828
Marion	160	290	3,000	3,450
Morris	160	320	9,000	9,480
Panola	0	0	0	0
Red River	733	1,642	75,000	77,375
Titus	0	300	45,500	45,800
Upshur	0	75	12,500	12,575
Wood	50	0	7,300	7,350
Total - Texas	6,844	19,396	570,280	596,520
Grand Total	-	-	2,070,866	2,146,336

1/Data from Soil Conservation Service questionnaires and TWC Bul.6515.
* Data for 1964, Texas Water Commission Bulletin 6515.

Exhibit 3 - Land Classified Suitable for Project-Type Irrigation,
Red River Basin Study Area

State and Area	Tributary Basin	ACRES						
		Gravity-type Irrigation					Sprinkler Irrigation	Total
		Class 1	Class 2	Class 3	Total	Riceland		
ARKANSAS								
Walnut Bayou	Intervening Areas - Ark. & Okla.	-	539	-	539	9,626	-	10,165
Index-Homan	McKinney Bayou	-	1,230	4,659	5,889	7,003	2,755	15,647
McKinney Bayou-Garland	McKinney Bayou	835	-	5,379	6,214	27,385	2,746	36,345
Spirit Lake	Maniece Bayou	249	1,270	-	1,519	1,869	-	3,388
Posten Bayou	Posten Bayou	362	3,913	804	5,079	15,138	231	20,448
Total Arkansas		1,446	6,952	10,842	19,240	61,021	5,732	85,993
LOUISIANA								
Posten Bayou	Posten Bayou	-	1,418	1,672	3,090	-	354	3,444
Willow Chute	Loggy Bayou	2,605	4,772	1,831	9,208	-	-	9,208
Red Chute	Loggy Bayou	189	6,290	3,529	10,008	-	-	10,008
North Caddo	Cypress Creek	7,417	15,295	1,021	23,733	-	-	23,733
South Caddo	Bayou Pierre	2,419	14,026	4,325	20,770	-	-	20,770
Lake End	Bayou Pierre	-	1,267	-	1,267	-	-	1,267
Clarence	Red River Main Stem	-	899	-	899	-	-	899
Campti	Red River Main Stem	-	1,667	-	1,667	-	-	1,667
Cane River	Cane River	12,621	6,690	1,486	20,797	-	-	20,797
Bayou Rapides	Bayou Rapides	7,123	3,512	97	10,732	-	-	10,732
Bayou Boeuf	Chatlin Lake	28,956	11,008	1,724	41,688	-	-	41,688
Bayou des Glaises	Chatlin Lake	9,088	4,457	-	13,545	-	-	13,545
Vick	Red River Backwater Area	-	-	-	-	-	3,157	3,157
Total Louisiana		70,418	71,301	15,685	157,404	-	3,511	160,915

Exhibit 3 - Land Classified Suitable for Project-Type Irrigation
Red River Basin Study Area (cont'd)

State and Area	Tributary Basin	ACRES						
		Gravity-type Irrigation						
		Class 1	Class 2	Class 3	Total	Riceland	Sprinkler Irrigation	Total
OKLAHOMA								
Colbert	Intervening Areas - Ark. & Okla.	984	526	106	1,616	-	150	1,766
Liberty Bottoms	do.	3,488	1,409	668	5,525	-	479	6,004
Yuba	do.	1,259	2,258	551	4,068	-	202	4,270
Boggy Cutoff	do.	144	226	-	370	-	471	841
Shoals Chapel	do.	-	383	285	668	-	-	668
Frogville	do.	311	770	754	1,835	-	325	2,160
Millerton	do.	818	1,351	1,718	3,887	-	879	4,766
Acworth	do.	830	2,063	1,661	4,554	1,528	-	6,082
Harris	do.	471	-	371	842	-	1,387	2,229
Tom	do.	369	137	-	506	-	-	506
Total Oklahoma[1/]		8,634	9,123	6,114	23,871	1,528	3,893	29,292
TEXAS								
Carpenters Bluff	Intervening Areas - Texas	1,668	782	-	2,450	-	30	2,480
Mulberry	do.	1,022	1,353	685	3,060	-	563	3,623
Telephone	do.	-	463	523	986	-	-	986
Riverby	do.	814	615	558	1,987	-	-	1,987
Direct	do.	480	1,713	290	2,483	-	165	2,648
Slate Shoals	do.	21	904	872	1,797	-	190	1,987
Kiomatia-Davenport	do.	145	846	398	1,389	-	-	1,389
DeKalb	do.	341	2,038	1,317	3,696	-	-	3,696
Clearlake	do.	-	-	253	253	1,309	-	1,562
Total Texas		4,491	8,714	4,896	18,101	1,309	948	20,358
Grand Total		84,989	96,090	37,537	218,616	63,858	14,084	296,558

Source: Bureau of Reclamation field surveys.

1/Does not include 20,920 acres of undifferentiated land in Blue River and Boggy Creek Tributary Basins.

Exhibit 5 - Harvested Acreages, Selected Crops: Irrigated[1/] and Nonirrigated, Red River Study Area[2/] - 1954 and 1959

Year and Practice	Selected crops							
	Cotton	Corn (grain)	Other hay crops	Alfalfa	Vegetables	Soybeans	Total selected crops	Percent of total acreage excluding rice
1954								
Nonirrigated, acres	849,227	478,259	610,806	80,782	26,227	95,879	2,141,180	.9017
Irrigated, acres	2,260	1,528	878	656	384	15	5,721	.3404
Percent of irrigated acreage	39.50	26.71	15.35	11.47	6.71	.26	100.00	
Irrigated / Nonirrigated	.0027	.0032	.0014	.0081	.0146	.0002	.0027	
1959								
Nonirrigated	564,533	325,443	609,404	63,608	22,025	114,942	1,699,955	.8859
Irrigated, acres	4,646	525	235	545	438	846	7,235	.8592
Percent of irrigated acreage	64.22	7.26	3.25	7.53	6.05	11.69	100.00	
Irrigated / Nonirrigated	.0082	.0016	.0004	.0086	.0199	.0074	.0042	

Source: U. S. Department of Commerce, Bureau of Census.

1/ Crops for which entire acreage was irrigated.

2/ Whole counties are represented in compiling these statistics.

Exhibit 4 - Irrigated Crops, Acreages: Irrigated Cropland Harvested, Crops for which Entire Acreage was Irrigated, Red River Basin Area, 1954 and 1959

Crop	1954 1/	1959 1/
	Acres	Acres
Crop for which entire acreage was irrigated		
Corn:		
For all purposes	1,621	873
Grain	1,528	525
Sorghum:		
For all purposes except sirup	551	27
Grain	300	20
Small grains harvested:		
Wheat	75	15
Oats	523	30
Rice	84,319	61,155
Peanuts:		
For all purposes	64	452
Alfalfa and mixture cut for hay	656	545
Other hay crops	878	235
Field seed crops	1	12
Cotton	2,260	4,646
Soybeans	15	846
Vegetables for sale	384	438
Land in bearing and nonbearing fruit orchard, groves	84	20
Pasture	-	282
Total	91,431	69,576
Irrigated cropland harvested	101,125	75,085

Source: Census of Agriculture, Crop Reporting Service

1/ Whole counties are represented.

Exhibit 6 - Cotton: Estimated Annual "Adjusted Normalized" Costs and Returns Per Acre With Irrigation, Bottomland Soils, Good Management, Red River Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Lint	Lb.	690	.24	165.60
Seed	Lb.	1201	.024	28.82
Total				194.42
Variable inputs:				
Seed	Lb.	32	.18	5.76
Fertilizer, N.P.K.	Lb.	60-40-40	.12-.10-.05	13.20
Power	Hr.	6.14	1.28	7.86
Other machinery	Acre	1.0	5.54	5.54
Herbicide	Acre	1.0	3.20	3.20
Insecticide and application	Acre	1.0	14.05	14.05
Hired hoeing	Times over	3.0	4.55	13.65
Land preparation	Acre	1.0	3.05	3.05
Water and ditch costs	Acre	1.0	3.00	3.00
Total preharvest costs				69.31
Defoliate and application	Acre	1.0	3.70	3.70
Mechanical pick	Cwt. s.c.	19.8	3.10	61.38
Haul, gin, wrap	Cwt. s.c.	19.8	1.14	21.98
Total harvesting costs				87.06
Annual interest on capital	Dol.	45.74	.06	2.74
Total specified costs				159.11
Returns above variable inputs				35.31
Hourly labor				12.56
Returns above variable inputs and labor				22.75

Exhibit 7 - Corn: Estimated Annual "Adjusted Normalized" Costs and Returns Per Acre With Irrigation, Bottomland Soils, Good Management, Red River Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Corn	Bu.	46	1.16	53.36
Variable inputs:				
Seed	Lb.	8.0	.205	1.64
Fertilizer, N.P.K.	Lb.	20-20-20	.12-.10-.05	5.40
Side dress	Lb.	30 N	.12	3.60
Power	Hr.	5.27	1.28	6.75
Other machinery	Acre	1.0	2.38	2.38
Land preparation	Acre	1.0	3.05	3.05
Water and ditch costs	Acre	1.0	3.00	3.00
Total preharvest costs				25.82
Custom harvest	Acre	1.0	5.18	5.18
Custom shelling	Bu.	46.0	.06	2.76
Haul	Bu.	46.0	.06	2.76
Total harvesting costs				10.70
Annual interest on operating capital	Dol.	16.27	.06	.98
Total specified costs				37.50
Returns above variable inputs				15.86
Hourly labor				10.10
Returns above variable inputs and labor				5.76

Exhibit 8 - Soybeans: Estimated Annual "Adjusted Normalized" Costs and Returns Per Acre With Irrigation, Bottomland Soils, Good Management, Red River Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Soybeans	Bu.	31	2.32	71.92
Variable inputs:				
Seed	Bu.	1.0	4.60	4.60
Fertilizer, N.P.K.	Lb.	0-40-40	.12-.10-.05	4.00
Insecticide	Acre	1	2.00	2.00
Power	Hr.	3.75	1.28	4.80
Other machinery	Acre	1.0	1.45	1.45
Land preparation	Acre	1.0	3.05	3.05
Water and ditch costs	Acre	1.0	3.00	3.00
Total preharvest costs				22.90
Combine	Hr.	0.5	6.84	3.42
Haul	Bu.	31.0	.09	2.79
Total harvesting costs				6.21
Annual interest on capital	Dol.	12.78	.06	.77
Total specified costs				29.88
Returns above variable inputs				42.04
Hourly labor				7.07
Returns above variable inputs and labor				34.97

Exhibit 9 - Alfalfa: Estimated Annual "Adjusted Normalized" Costs and Returns Per Acre With Irrigation, Bottomland Soils, Good Management, Red River Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	4	29.71	118.84
Cost of establishing:				
Breaking	Hr.	1.3	1.91	2.48
Disking	Hr.	1.0	2.05	2.05
Harrowing	Hr.	.5	1.94	.97
Land preparation for irrigation	Acre	1.0	3.05	3.05
Fertilizer (6-24-24)	Cwt.	2.5	4.50	11.25
Seed, inoculated	Hr.	20	.51	10.20
Lime, custom	Ton	2	5.00	10.00
Plant and fertilizer	Hr.	.7	2.08	14.56
Packing	Hr.	.2	2.43	.49
Water and ditch costs	Acre	1.0	3.00	3.00
Hourly labor	Hr.	6.2	1.25	7.75
Total establishing costs				65.80
Annual costs:				
Amortized at 6% over a 4-year period				18.99
Maintenance costs				11.60
Supplemental irrigation				4.10
Total annual costs				34.69
Variable costs:				
Cut, rake, bale, and storage (custom)	Ton	4	9.20	36.80
Labor	Hr.	1.0	1.25	1.25
Total variable costs				38.05
Total annual costs of production above				72.74
Returns annual and variable costs				46.10

Exhibit 10 - Pasture, Tame: Estimated Annual "Adjusted Normalized" Costs and Returns Per Acre With Irrigation, Bottomland Soils, Good Management, Red River Study Area

Item		Amount
		Dollars
Production:		
Hay, or grazing	11 AUM, or 2,500 lbs. air-dried forage @ $23.76 per ton	29.70
Costs of establishing:		
Fescue and white clover		33.51
Common bermuda and lespedeza		36.23
Annual costs:		
Amortized:		
Fescue and white clover		4.55
Common bermuda and lespedeza		3.73
Annual maintenance costs		5.28
Supplemental irrigation costs		4.10
Total annual costs:		
Fescue and white clover		13.93
Common bermuda and lespedeza		13.11
Returns to land and management (after pasture has been established):		
Fescue and white clover		15.77
Common bermuda and lespedeza		16.59

Exhibit 11 - Prices: Adjusted Normalized for Specific Commodities, Arkansas, Louisiana, Oklahoma, Texas, and 4-State Average[1/]

Commodity	Unit	Arkansas	Louisiana	Oklahoma	Texas	4-State average[1/]
		Dols.	Dols.	Dols.	Dols.	Dols.
Wheat	Bu.	1.27	1.27	1.31	1.31	1.29
Rice	Cwt.	4.75	4.75	-	4.84	4.78
Corn	Bu.	1.17	1.21	1.11	1.17	1.16
Oats	Bu.	.68	.73	.63	.68	.68
Barley	Bu.	.84	-	.79	.84	.82
Sorghums	Bu.	1.11	1.11	.95	.95	1.04
Cotton, lint	Lb.	.26	.25	.23	.24	.24
Cottonseed	Ton	47.04	46.08	47.04	48.00	47.04
Soybeans	Bu.	2.47	2.30	2.25	2.25	2.32
Potatoes	Cwt.	3.20	2.55	3.20	2.87	2.95
Sweet potatoes	Cwt.	4.52	2.57	5.03	4.52	4.16
Hay, all[2/]	Ton	23.54	24.64	22.66	24.20	23.76
Alfalfa[2/ 3/]	Ton	29.26	33.33	25.98	30.27	29.71
Cattle	Cwt.	18.04	16.40	19.48	18.45	18.09
Calves	Cwt.	22.56	23.04	24.00	23.04	23.16
Sheep	Cwt.	5.47	5.98	5.98	7.52	6.23
Lambs	Cwt.	16.02	15.12	17.64	15.12	15.97
Hogs	Cwt.	15.05	14.44	15.05	15.05	14.89
Commercial broilers	Lb.	.13	.14	.14	.14	.14
Turkeys	Lb.	.20	.22	.19	.20	.20
Eggs	Doz.	.38	.40	.30	.34	.35

Source: Interim Price Standards for Planning and Evaluating Water and Land Resources, Interdepartmental Staff Committee of the Water Resources Council, Washington, D. C., April 1966.

1/The prices presented are an average for the four states in the basin complex.

2/Price of hay sold baled.

3/Alfalfa hay price was computed by ERS, Little Rock, Arkansas

Exhibit 12 - Costs and Returns: Adjusted Normalized, for Selected Irrigated Crops, Bottomland Soils, Good Management, Red River Study Area

Item	Cotton	Corn	Soybeans	Alfalfa	Other hay or tame pasture[1]
	Dols.	Dols.	Dols.	Dols.	Dols.
Income	194.42	53.36	71.92	118.84	29.70
Costs of production	171.67	47.60	36.95	72.74	13.93[2] 13.11[3]
Returns above variable inputs and labor	22.75	4.76	34 97	46.18	15.77[2] 16.59[3]

[1]Other hay, or tame pasture was considered to be "fescue and white clover," or "common bermuda and lespedeza."

[2]Fescue and white clover.

[3]Common bermuda and lespedeza.

Exhibit 13 - Costs and Returns: Adjusted Normalized, for Selected Crops Without Irrigation, Bottomland Soils, Good Management, Red River Study Area

Item	Cotton	Corn	Soybeans	Alfalfa	Other hay or tame pasture[1]
	Dols.	Dols.	Dols.	Dols.	Dols.
Income	150.74	35.96	53.36	62.39	19.01
Costs of production	145.20	35.51	24.11	49.79	9.73[2] 8.99[3]
Returns above variable inputs and labor	5.54	.45	29.25	12.60	9.28[2] 10.02[3]

[1] Other hay, or tame pasture was considered to be "fescue and white clover," or "common bermuda and lespedeza."

[2] Fescue and white clover.

[3] Common bermuda and lespedeza.

Exhibit 14 - Returns Above Variable Inputs and Labor: Adjusted Normalized, for Selected Crops, Irrigated and Nonirrigated, Bottomland Soils, Good Management, Red River Study Area

Crop	Irrigated	Nonirrigated	Difference in Returns
	Dols.	Dols.	Dols.
Cotton	22.75	5.54	17.21
Corn	5.76	.45	5.31
Soybeans	34.97	29.25	5.72
Alfalfa	46.10	12.60	33.50
Other hay, or tame pasture[1]	15.77[2] 16.59[3]	9.28[2] 10.02[3]	6.49[2] 6.57[3]

[1] Other hay, or tame pasture was considered to be "fescue and white clover," or "common bermuda and lespedeza."

[2] Fescue and white clover.

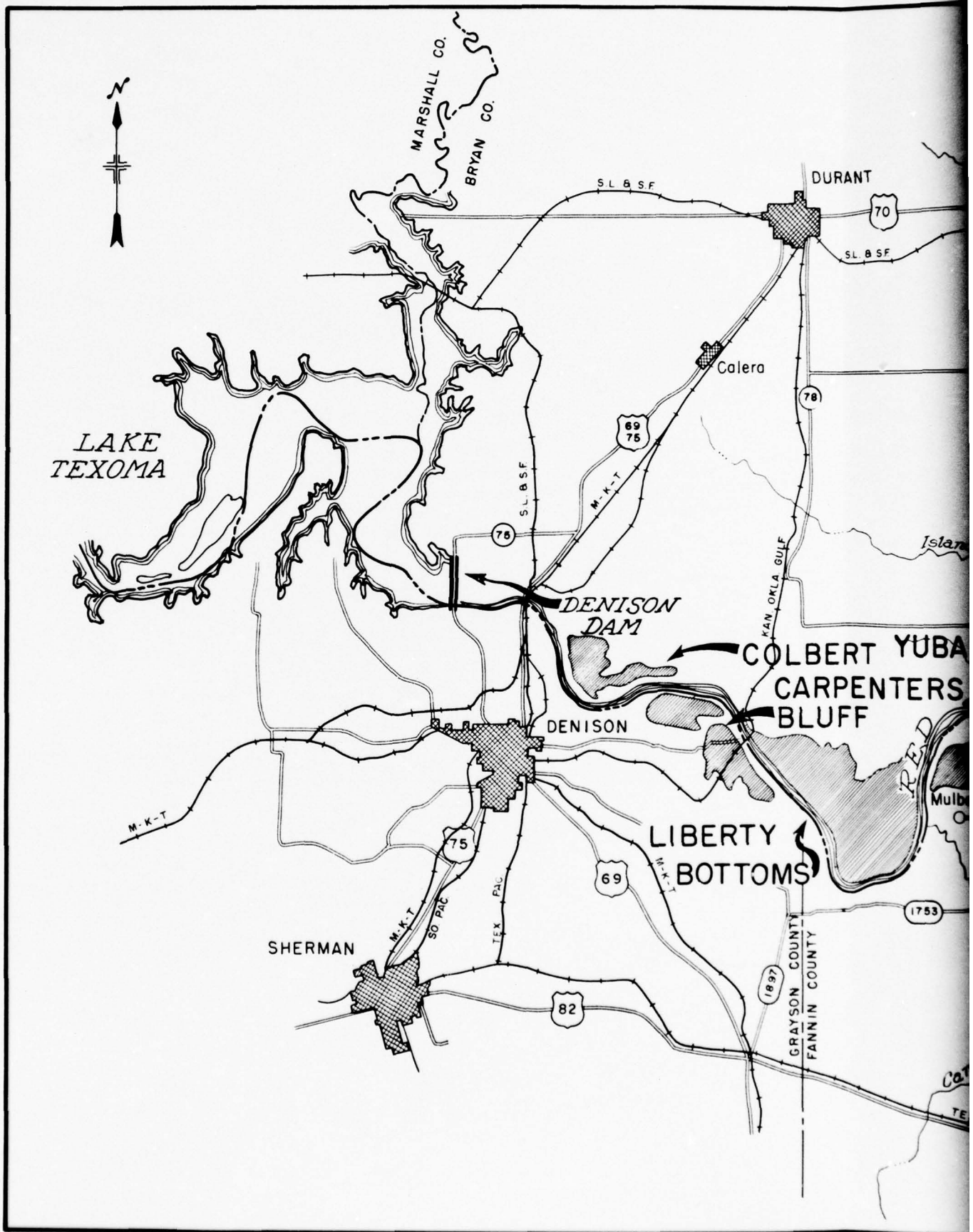
[3] Common bermuda and lespedeza.

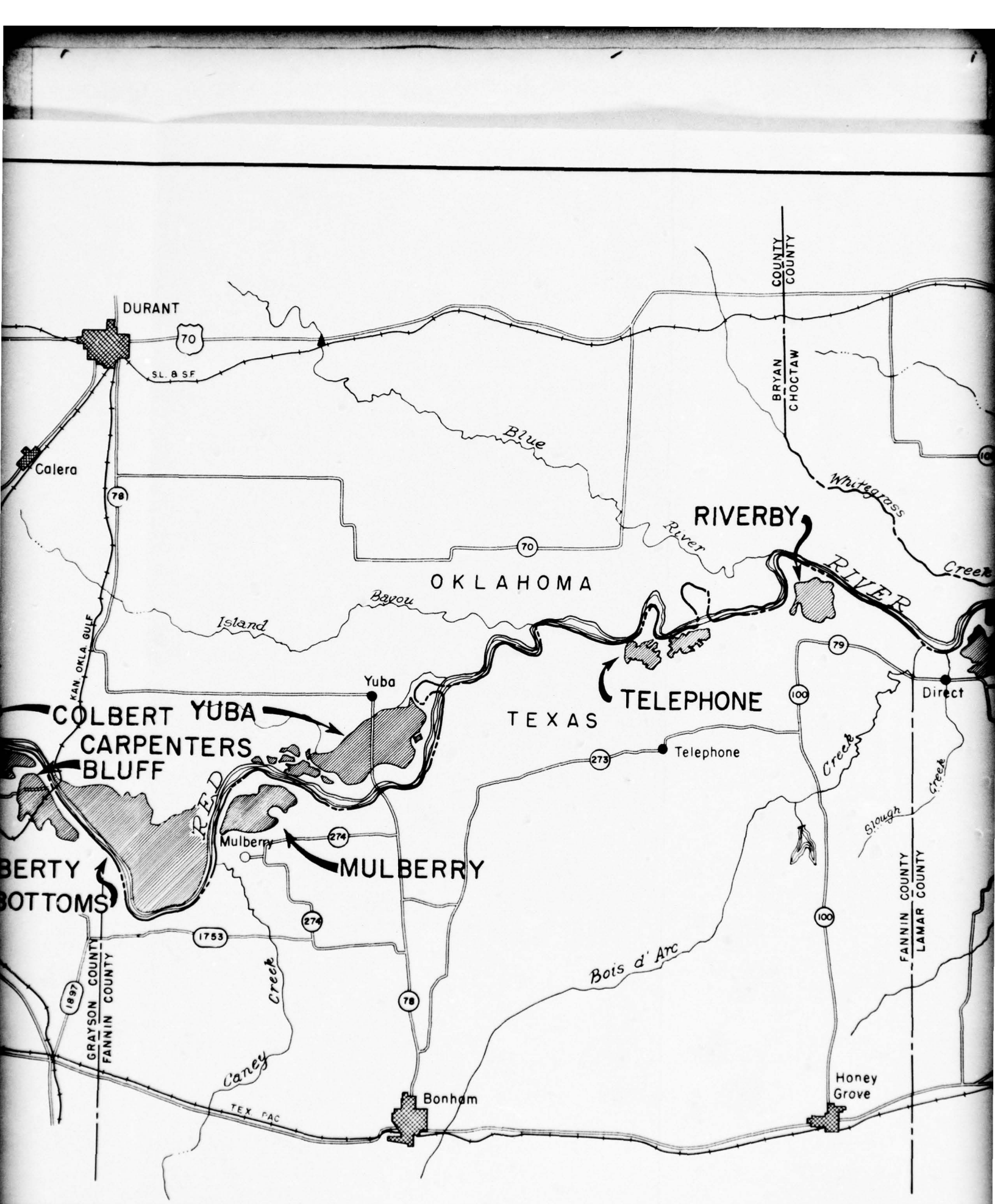
Exhibit 15 - Existing and Potential Irrigation Development
Red River Basin Study Area

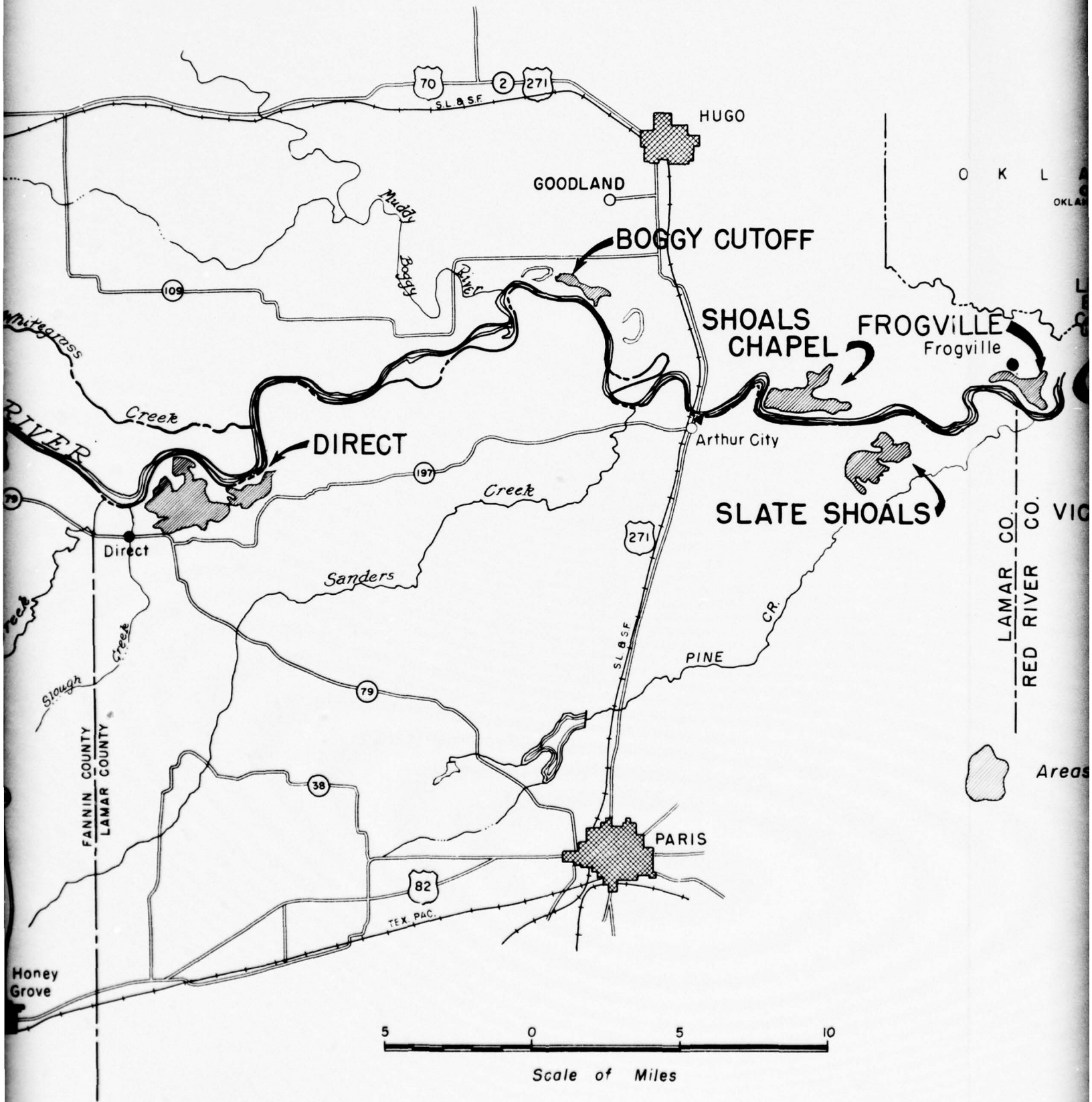
State and Tributary Basin	Existing	1980			2030			2080		
	Individual	Project	Individual	Total	Project	Individual	Total	Project	Individual	Total
	(Acres)									
Arkansas										
Cypress Creek	0	0	200	200	0	800	800	0	1,500	1,500
Bois d'Arc Creek and Maniece Bayou	1,000	0	1,400	1,400	1,700	1,000	2,700	3,400	600	4,000
Little River	550	0	700	700	0	1,300	1,300	0	2,000	2,000
Loggy Bayou	800	0	900	900	0	1,300	1,300	0	1,800	1,800
McKinney Bayou	2,000	0	9,000	9,000	26,000	6,500	32,500	52,000	4,000	56,000
Intervening Areas - Ark.	450	0	2,500	2,500	5,100	4,100	9,200	10,200	5,800	16,000
Posten Bayou	1,900	0	5,000	5,000	10,200	5,300	15,500	20,400	5,600	26,000
Sulphur River	0	0	700	700	0	1,700	1,700	0	2,700	2,700
Total Arkansas	6,700	0	20,400	20,400	43,000	22,000	65,000	86,000	24,000	110,000
Louisiana										
Bayous Nantachie and Rigolette	400	0	900	900	0	2,400	2,400	0	4,000	4,000
Bayou Pierre	1,200	3,100	7,500	10,600	12,500	29,300	41,800	22,000	51,000	73,000
Bayou Rapides and Jean de Jean	1,600	10,500	1,600	12,100	10,700	7,300	18,000	10,800	13,200	24,000
Black and Saline Lakes	400	0	700	700	0	1,800	1,800	0	3,000	3,000
Cane River	1,800	15,000	12,100	27,100	17,900	26,100	44,000	20,800	39,200	60,000
Chatlin Lake Area	11,100	20,500	11,100	31,600	37,800	28,000	65,800	55,200	44,800	100,000
Cypress Creek	600	0	4,700	4,700	11,900	6,100	18,000	23,800	8,200	32,000
Loggy Bayou	900	8,400	900	9,300	13,800	12,800	26,600	19,200	24,800	44,000
Posten Bayou	200	0	700	700	1,700	600	2,300	3,400	600	4,000
Red River Backwater	4,500	0	8,600	8,600	1,600	20,700	22,300	3,200	32,800	36,000
Red River Main Stem	700	0	3,200	3,200	1,300	10,100	11,400	2,600	17,400	20,000
Total Louisiana	23,400	57,500	52,000	109,500	109,200	145,200	254,400	161,000	239,000	400,000

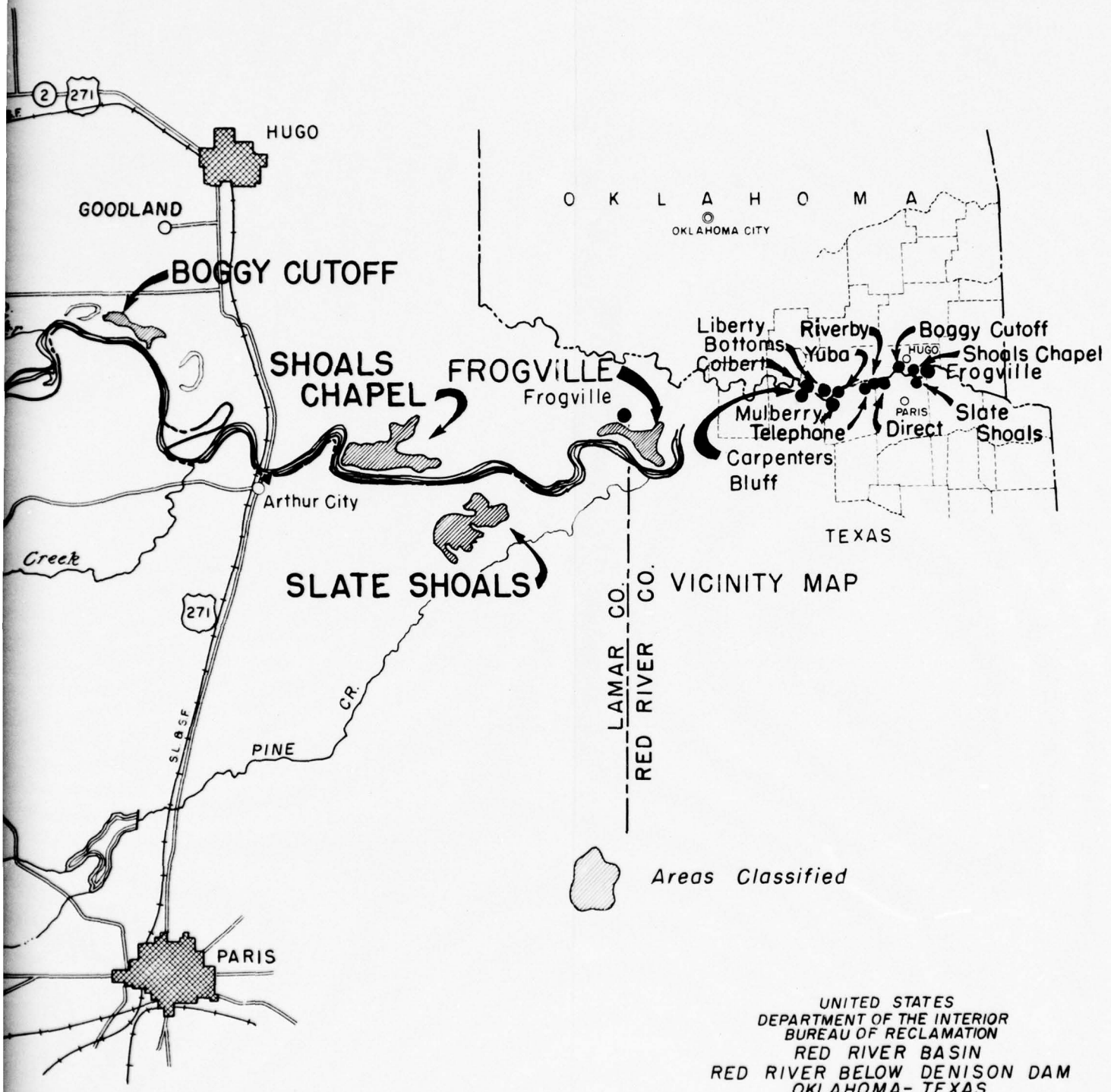
Exhibit 15 - Existing and Potential Irrigation Development
Red River Basin Study Area (cont'd)

State and Tributary Basin	Existing	1980			2030			2080		
	Individual	Project	Individual	Total	Project	Individual	Total	Project	Individual	Total
	(Acres)									
Oklahoma										
Blue River	300	0	3,000	3,000	5,000	6,500	11,500	10,000	10,000	20,000
Boggy Creek	300	0	4,800	4,800	5,500	14,500	20,000	11,000	24,000	35,000
Kiamichi River	200	0	2,800	2,800	0	11,400	11,400	0	20,000	20,000
Little River	0	0	1,300	1,300	0	5,600	5,600	0	10,000	10,000
Intervening Areas - Oklahoma	3,900	0	12,100	12,100	14,500	27,000	41,500	29,000	42,000	71,000
Total Oklahoma	4,700	0	24,000	24,000	25,000	65,000	90,000	50,000	106,000	156,000
Texas										
Cypress Creek	900	0	2,000	2,000	0	5,900	5,900	0	9,800	9,800
Intervening Areas - Texas, Barkman Creek, & McKinney Bayou	5,300	0	14,000	14,000	10,000	34,500	44,500	20,000	55,000	75,000
Sulphur River	600	0	2,400	2,400	0	8,600	8,600	0	14,800	14,800
Total Texas	6,800	0	18,400	18,400	10,000	49,000	59,000	20,000	79,600	99,600
Grand Total	41,600	57,500	114,800	172,300	187,200	281,200	468,400	317,000	448,600	765,600


MARSHALL CO.
BRYAN CO.
S L & S F
DURANT
70
SL & SF
Calera
78
69
75
LAKE
TEXOMA
M-K-T
S L & S F
78
Islan
KAN OKLA GULF
DENISON
DAM
COLBERT
YUBA
CARPENTERS
BLUFF
DENISON
RED
Mulb
M-K-T
75
LIBERTY
BOTTOMS
69
M-K-T
1753
SHERMAN
M-K-T
SO PAC
TEX PAC
1897
GRAYSON COUNTY
FANNIN COUNTY
82


DURANT
70
SL. & SF
Calera
78
Blue
COUNTY
COUNTY
BRYAN
CHOCTAW
Whitegrass
Creek
RIVERBY
River
RIVER
OKLAHOMA
70
Bayou
Island
KAN. OKLA. GULF
Yuba
COLBERT YUBA
CARPENTERS
BLUFF
TELEPHONE
TEXAS
79
100
Direct
Telephone
273
Creek
Slough
Creek
RED
Mulberry
274
MULBERRY
BERTY
BOTTOMS
1753
274
100
FANNIN COUNTY
LAMAR COUNTY
GRAYSON COUNTY
FANNIN COUNTY
1897
Caney
Creek
78
Bois d' Arc
Honey
Grove
TEX. PAC.
Bonham


70
2
271
S.L.&S.F.
HUGO
GOODLAND
Muddy
Boggy
BOGGY CUTOFF
Boggy
Creek
109
SHOALS
CHAPEL
FROGVILLE
Frogville
Creek
DIRECT
Arthur City
197
Creek
SLATE SHOALS
271
Direct
Sanders
CR.
PINE
S.L.&S.F.
Slough
Creek
79
FANNIN COUNTY
LAMAR COUNTY
LAMAR CO.
RED RIVER CO.
38
PARIS
82
TEX. PAC.
Honey
Grove
5
0
5
10
Scale of Miles

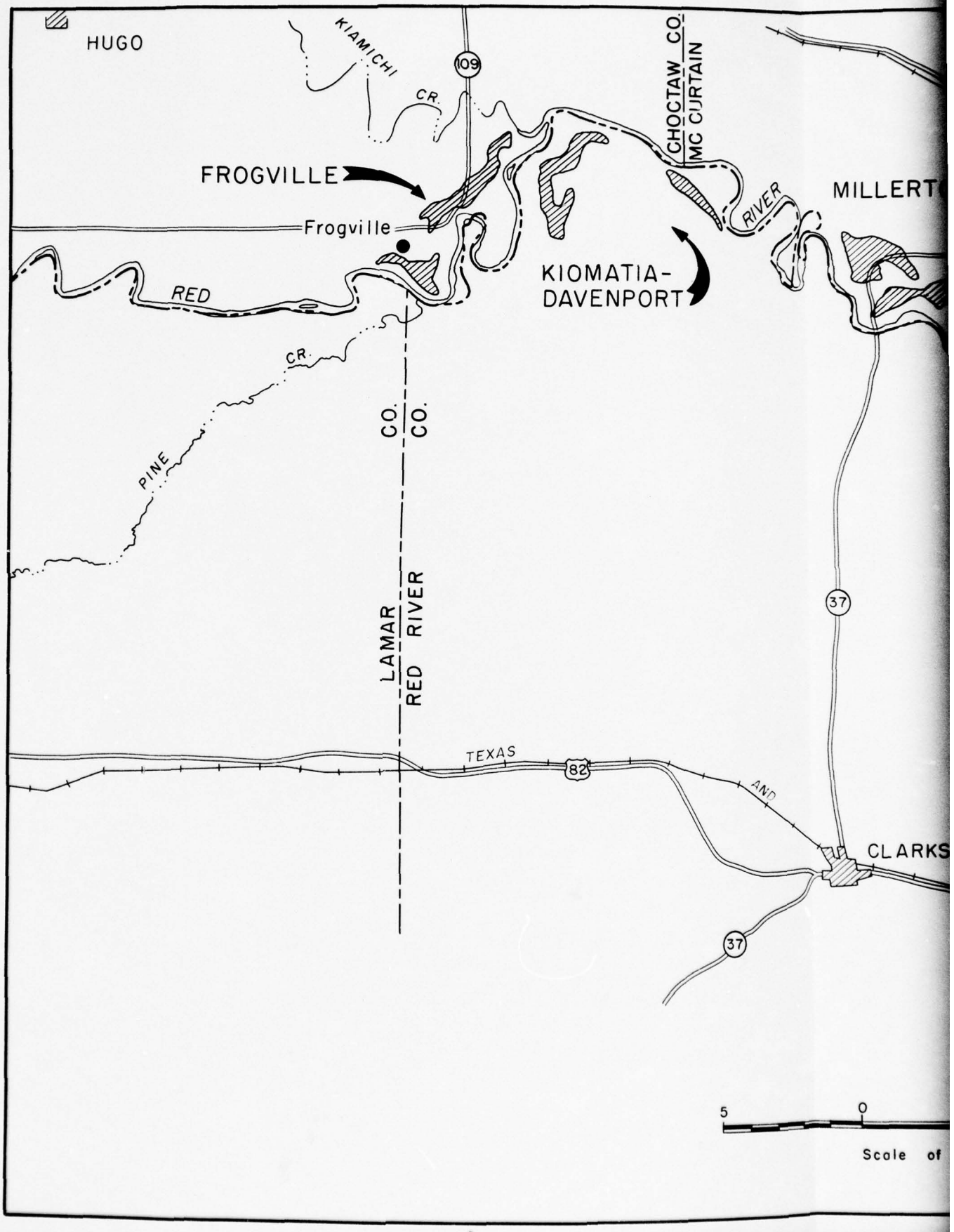


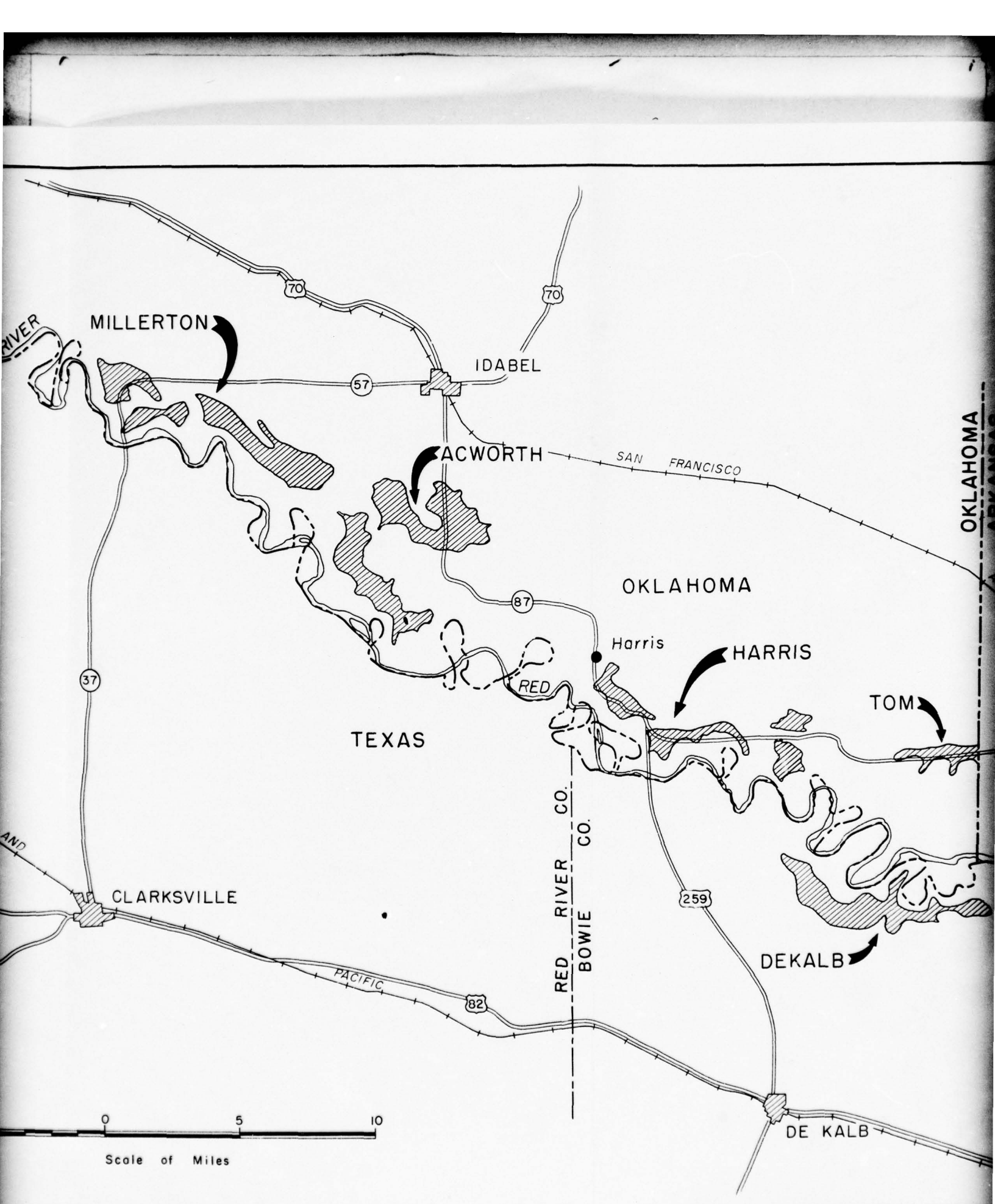
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA - TEXAS

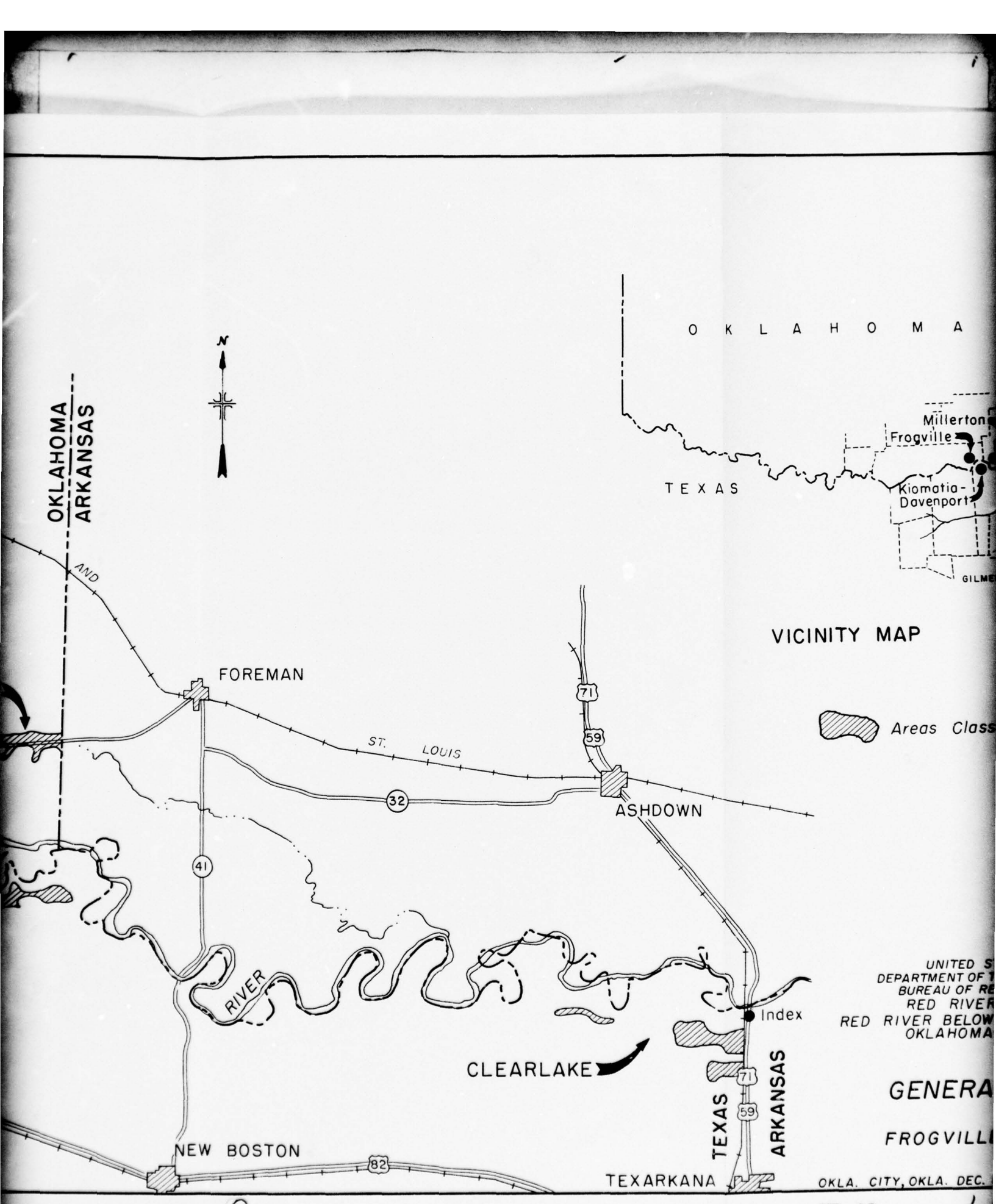
GENERAL MAP

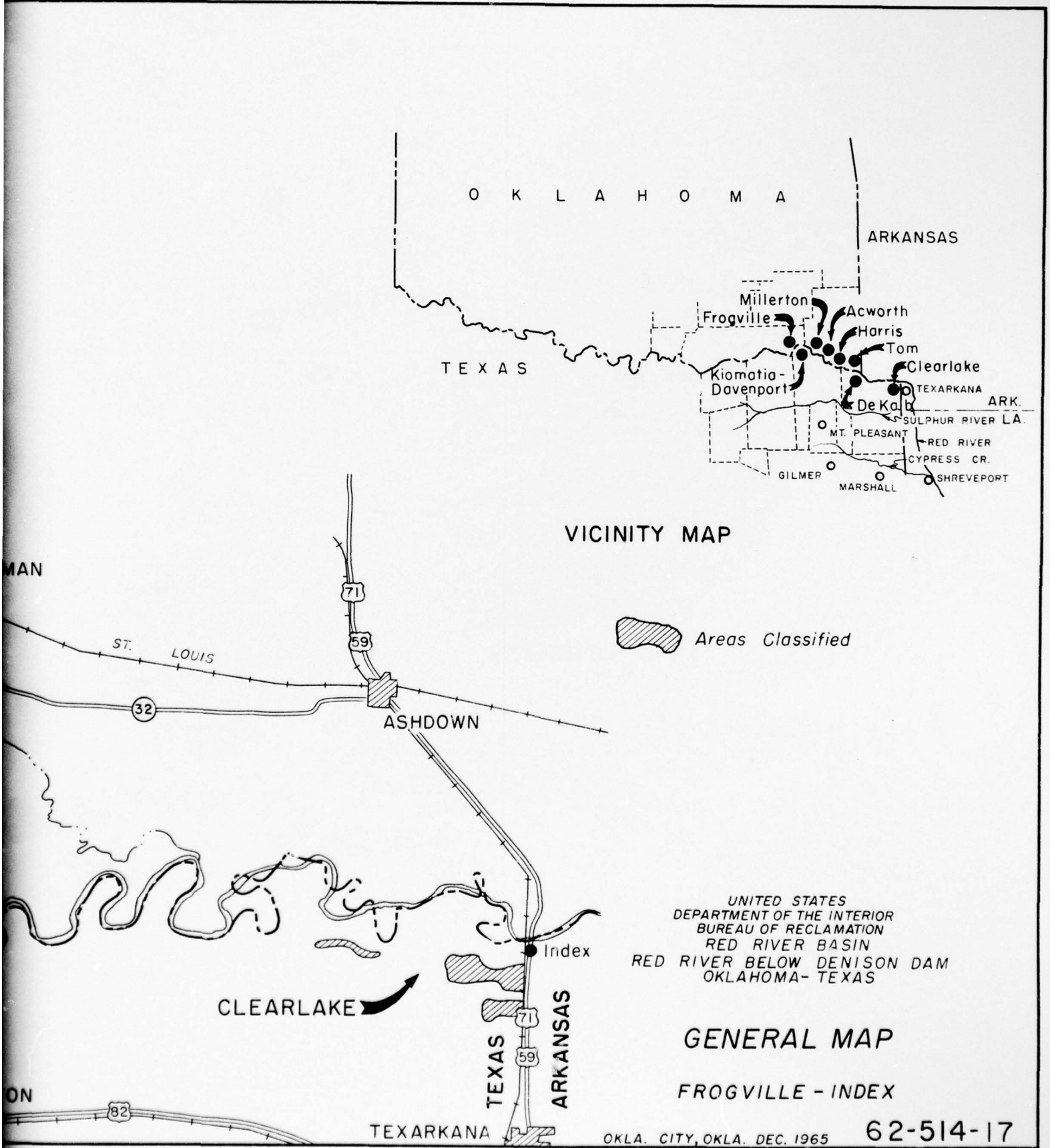
DENISON DAM - FROGVILLE

OKLA. CITY, OKLA. DEC. 1965 62-514-26

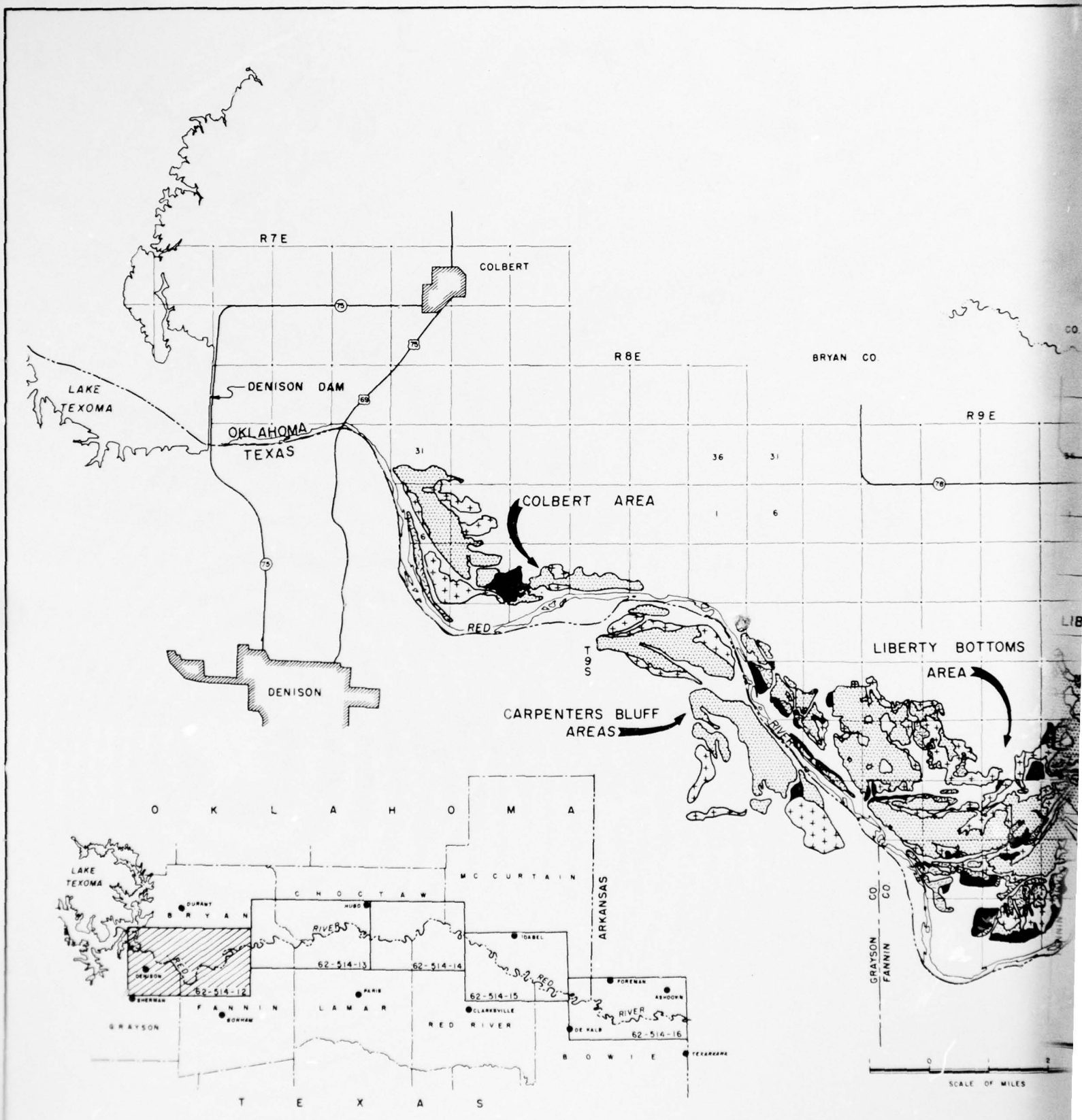

HUGO
KIAMICHI
CR.
109
CHOCTAW CO.
MC CURTAIN
FROGVILLE
Frogville
RIVER
MILLERT
RED
KIOMATIA-
DAVENPORT
CR.
PINE
CO.
CO.
LAMAR
RED RIVER
37
TEXAS
82
AND
CLARKS
37
5
0
Scale of


MILLERTON
IDABEL
ACWORTH
SAN FRANCISCO
OKLAHOMA
OKLAHOMA
Harris
HARRIS
TOM
RED
TEXAS
CO.
RIVER
CO.
RED
BOWIE
CLARKSVILLE
PACIFIC
DEKALB
DE KALB
70
70
57
87
37
259
82
0
5
10
Scale of Miles


OKLAHOMA
TEXAS
Millerton
Frogville
Kiomatia-
Davenport
GILMER
VICINITY MAP
OKLAHOMA
ARKANSAS
AND
FOREMAN
ST. LOUIS
71
59
32
ASHDOWN
41
RIVER
Index
CLEARLAKE
71
59
TEXAS
ARKANSAS
NEW BOSTON
82
TEXARKANA
Areas Class
UNITED S
DEPARTMENT OF
BUREAU OF RE
RED RIVER
RED RIVER BELOW
OKLAHOMA
GENERA
FROGVILL
OKLA. CITY, OKLA. DEC.


OKLAHOMA
ARKANSAS
TEXAS
Millerton
Frogville
Acworth
Harris
Tom
Clearlake
Kiomatia-
Davenport
TEXARKANA
ARK.
DeKalb
SULPHUR RIVER
LA.
MT. PLEASANT
RED RIVER
CYPRESS CR.
GILMER
MARSHALL
SHREVEPORT
VICINITY MAP
MAN
71
59
ST. LOUIS
32
ASHDOWN
Areas Classified
Index
CLEARLAKE
71
59
TEXAS
ARKANSAS
ON
82
TEXARKANA
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA- TEXAS
GENERAL MAP
FROGVILLE - INDEX
OKLA. CITY, OKLA. DEC. 1965
62-514-17

4

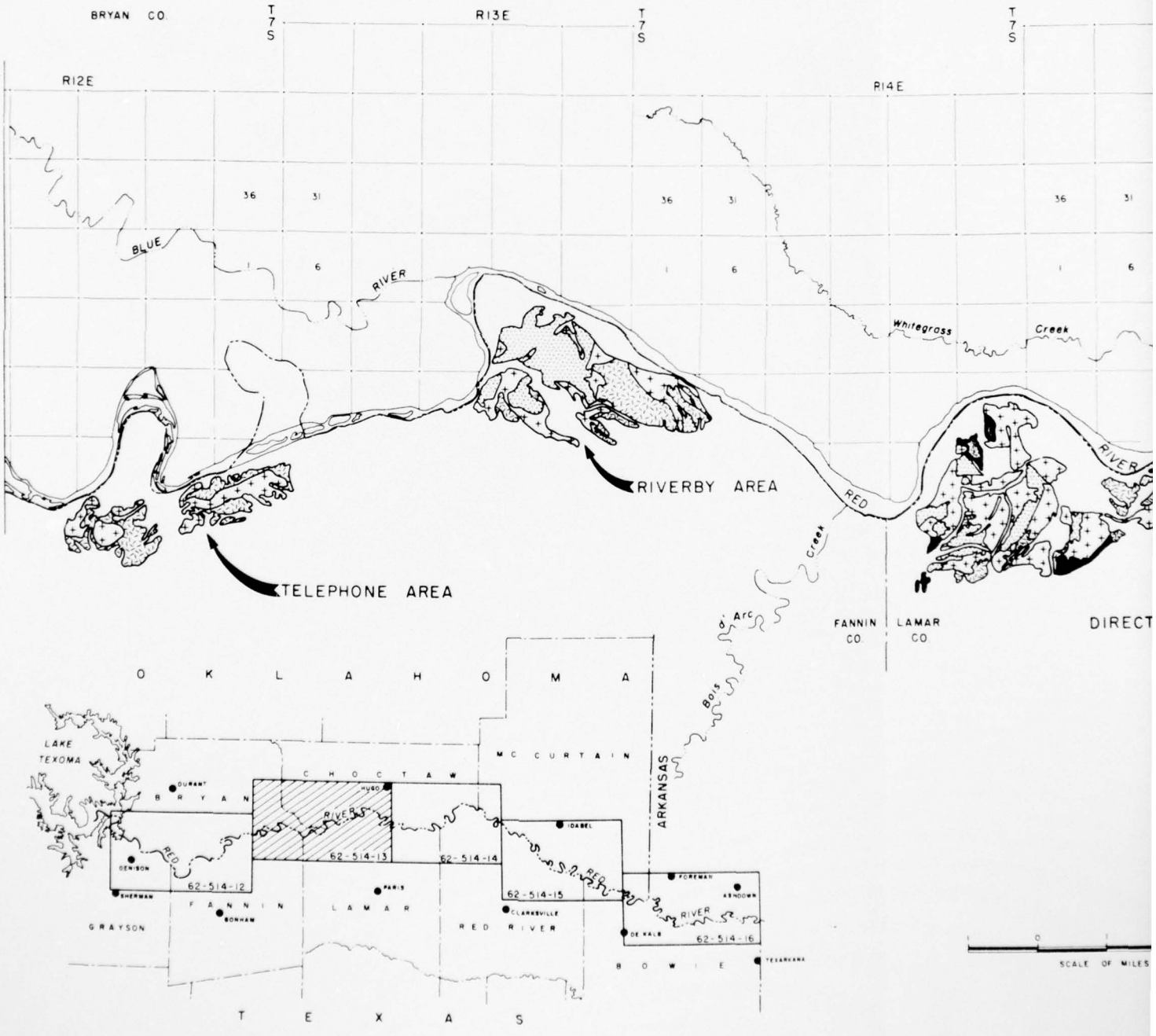

R7E
COLBERT
R8E
BRYAN CO.
R9E
LAKE TEXOMA
DENISON DAM
OKLAHOMA
TEXAS
COLBERT AREA
RED
DENISON
T 9 S
LIBERTY BOTTOMS AREA
CARPENTERS BLUFF AREAS
RIVER
OKLAHOMA
LAKE TEXOMA
MC CURTAIN
CHOCTAW
ARKANSAS
DURANT
BRYAN
HUGO
RED RIVER
TOMBELL
62-514-13
62-514-14
62-514-15
62-514-16
62-514-12
FOREMAN
ASHDOWN
DENISON
SHERMAN
PARIS
FANNIN
LAMAR
BONHAM
CLARKSVILLE
DE KALB
TEXARKANA
GRAYSON
BOWIE
TEXAS
GRAYSON CO
FANNIN CO
SCALE OF MILES

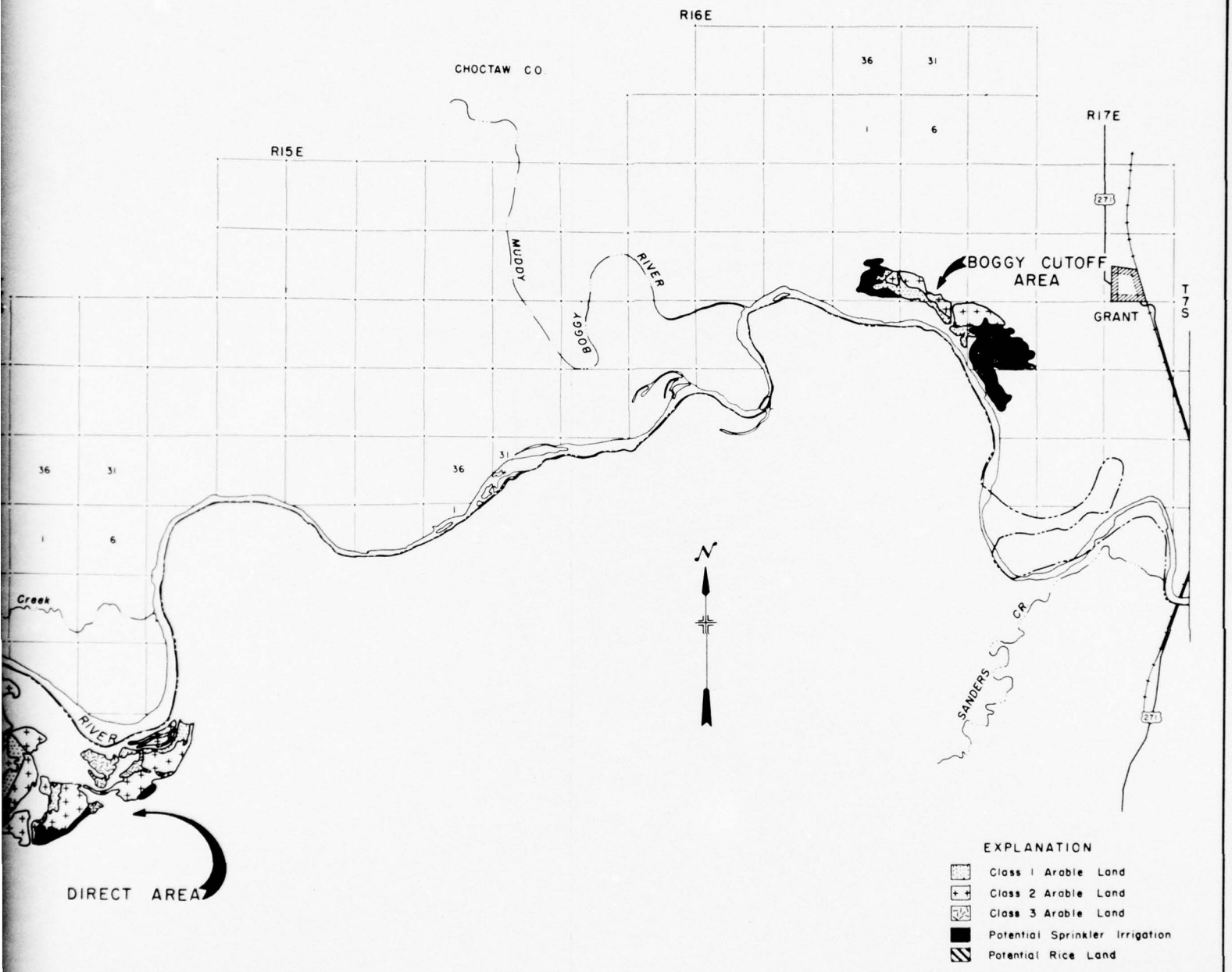
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA - TEXAS

LAND CLASSIFICATION

OKLAHOMA CITY, OKLA NOV 1965

62-514-12


BRYAN CO.
T 7 S
R12E
R13E
R14E
BLUE
RIVER
Whitegrass
Creek
RED
RIVER
RIVERBY AREA
TELEPHONE AREA
Arc
Bois
d'
Creek
FANNIN CO.
LAMAR CO.
DIRECT
OKLAHOMA
LAKE TEXOMA
MC CURTAIN
CHOCTAW
HUGO
DURANT
BRYAN
RED
RIVER
62-514-13
62-514-14
62-514-15
62-514-16
62-514-12
IDABEL
FOREMAN
ARKOMA
ARKANSAS
DENISON
SHERMAN
PARIS
CLARKSVILLE
DE KALB
TEXARKANA
FANNIN
LAMAR
RED RIVER
BONHAM
GRAYSON
BOWIE
TEXAS
SCALE OF MILES



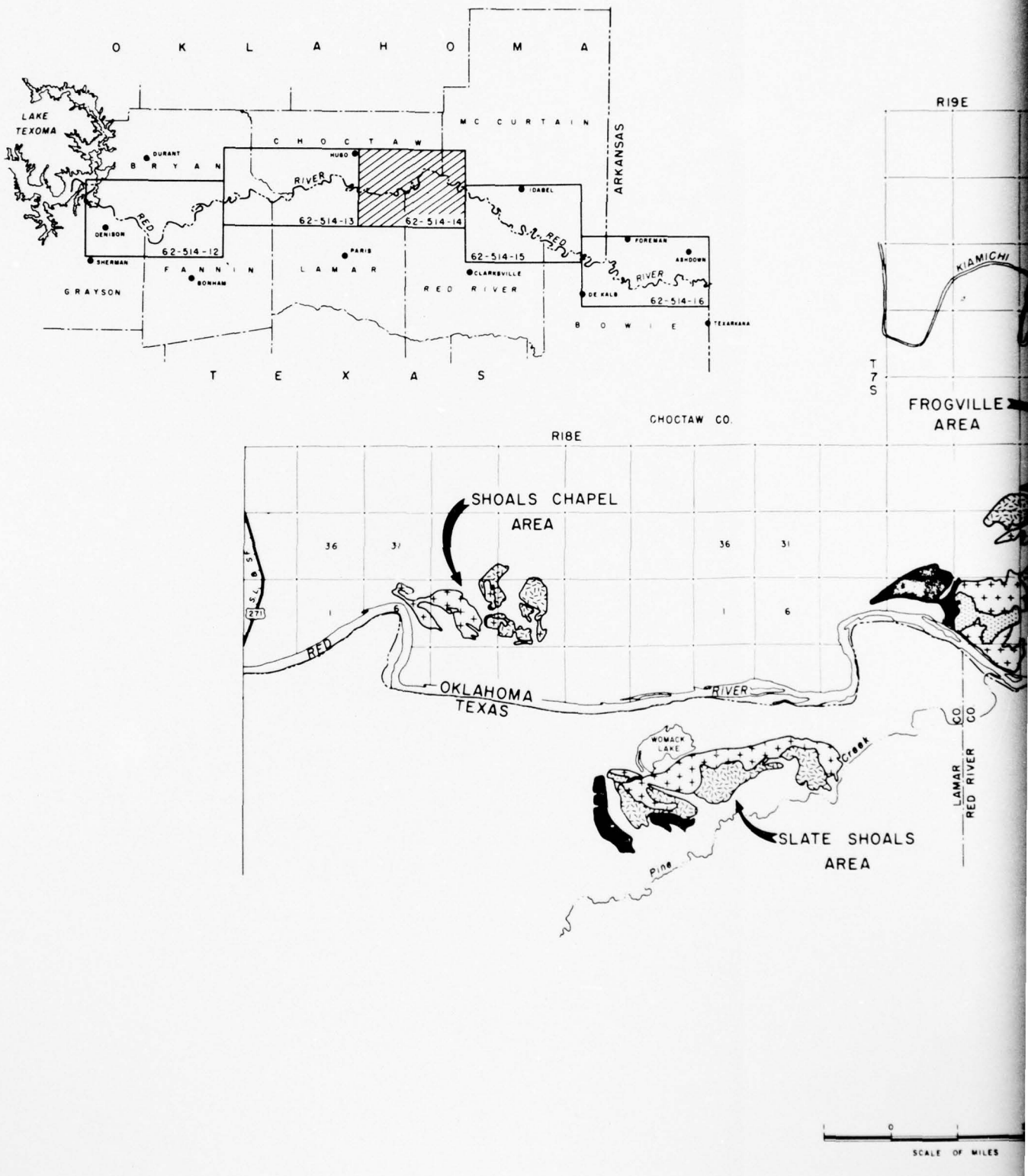
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA - TEXAS

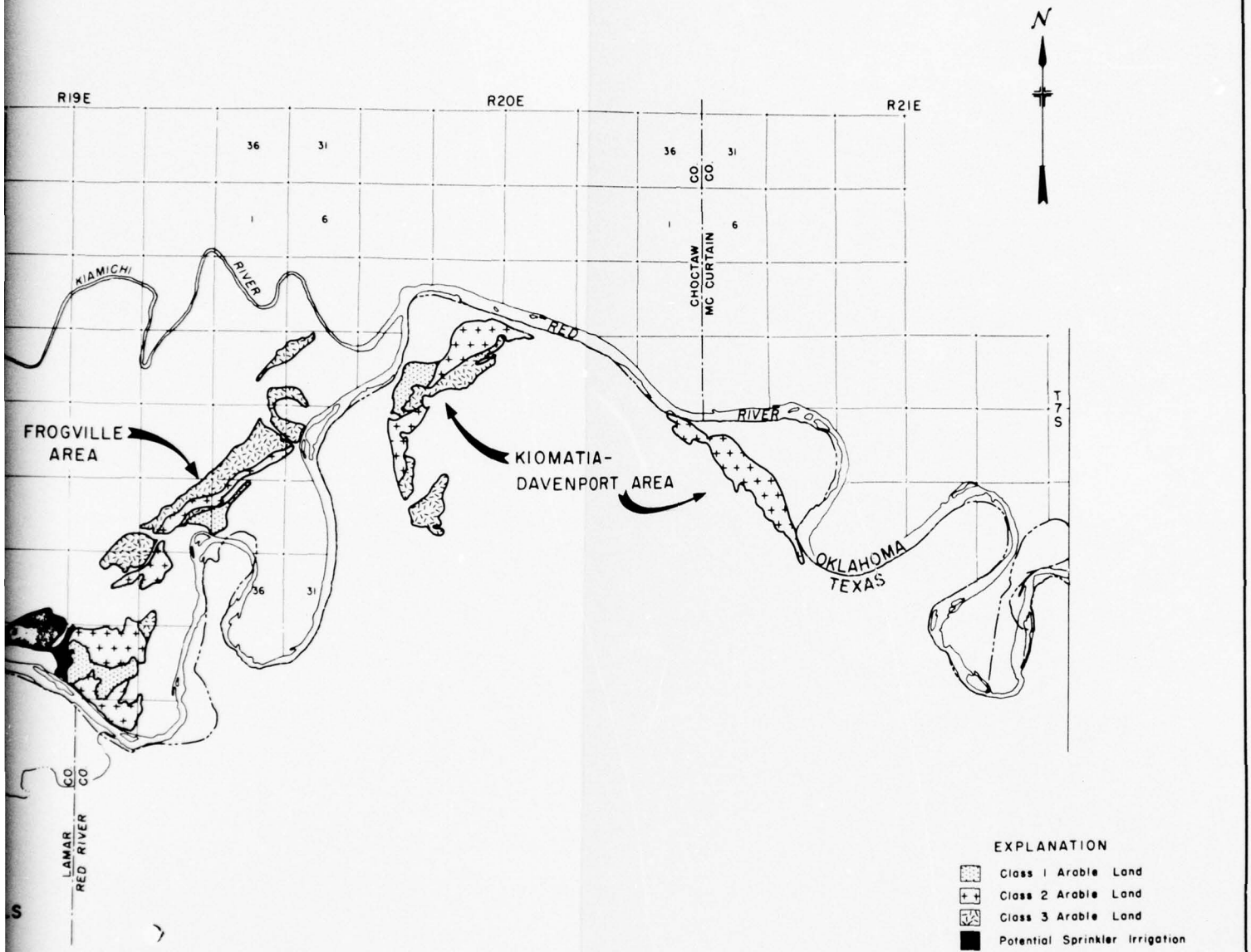
LAND CLASSIFICATION

OKLAHOMA CITY, OKLA NOV 1965

62-514-13

2

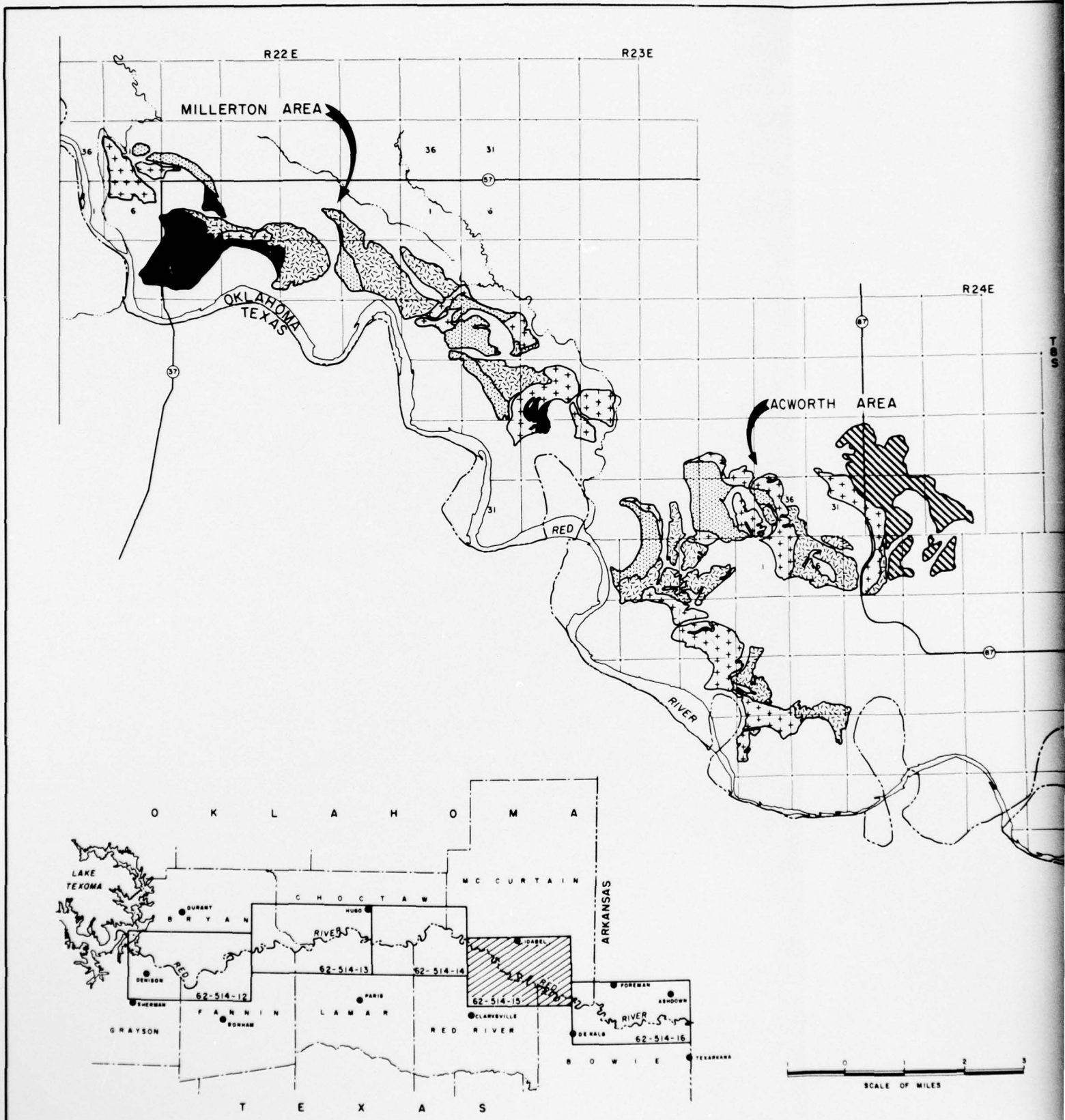

O K L A H O M A
LAKE TEXOMA
DURANT
B R Y A N
C H O C T A W
MC CURTAIN
ARKANSAS
HUGO
IDABEL
RIVER
RED
DENISON
62-514-12
62-514-13
62-514-14
62-514-15
62-514-16
SHERMAN
BONHAM
PARIS
CLARKSVILLE
FOREMAN
ASHDOWN
DE KALB
TEXARKANA
F A N N I N
L A M A R
R E D R I V E R
B O W I E
GRAYSON
T E X A S
R19E
KIAMICHI
T
7
S
FROGVILLE
AREA
CHOCTAW CO.
R18E
SHOALS CHAPEL
AREA
36
31
1
6
271
OKLAHOMA
TEXAS
WOMACK
LAKE
Creek
Pine
LAMAR CO
RED RIVER CO
SLATE SHOALS
AREA
0
SCALE OF MILES

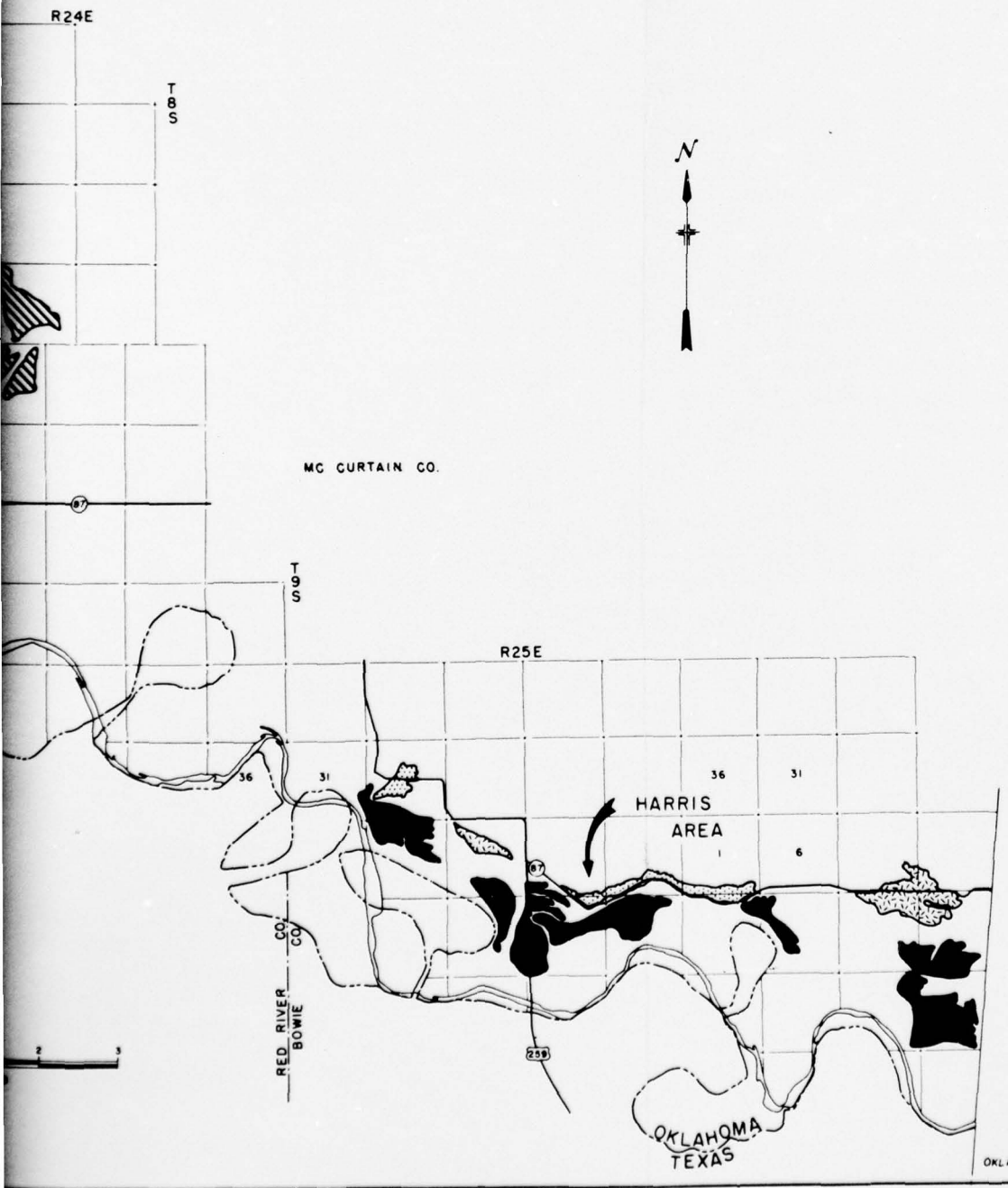


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA - TEXAS

LAND CLASSIFICATION

OKLAHOMA CITY, OKLA. NOV 1965 62-514-14


R22E
R23E
R24E
MILLERTON AREA
ACWORTH AREA
OKLAHOMA
TEXAS
RED
RIVER
36
31
6
1
37
87
T8S
O K L A H O M A
LAKE TEXOMA
MC CURTAIN
CHOCTAW
BRYAN
DURANT
HUGO
IDABEL
ARKANSAS
RIVER
RED
DENISON
SHERMAN
BONHAM
PARIS
CLARKSVILLE
DE KALB
FOREMAN
ASHDOWN
TEXARKANA
62-514-12
62-514-13
62-514-14
62-514-15
62-514-16
GRAYSON
FANNIN
LAMAR
RED RIVER
BOWIE
T E X A S
0
1
2
3
SCALE OF MILES



EXPLANATION

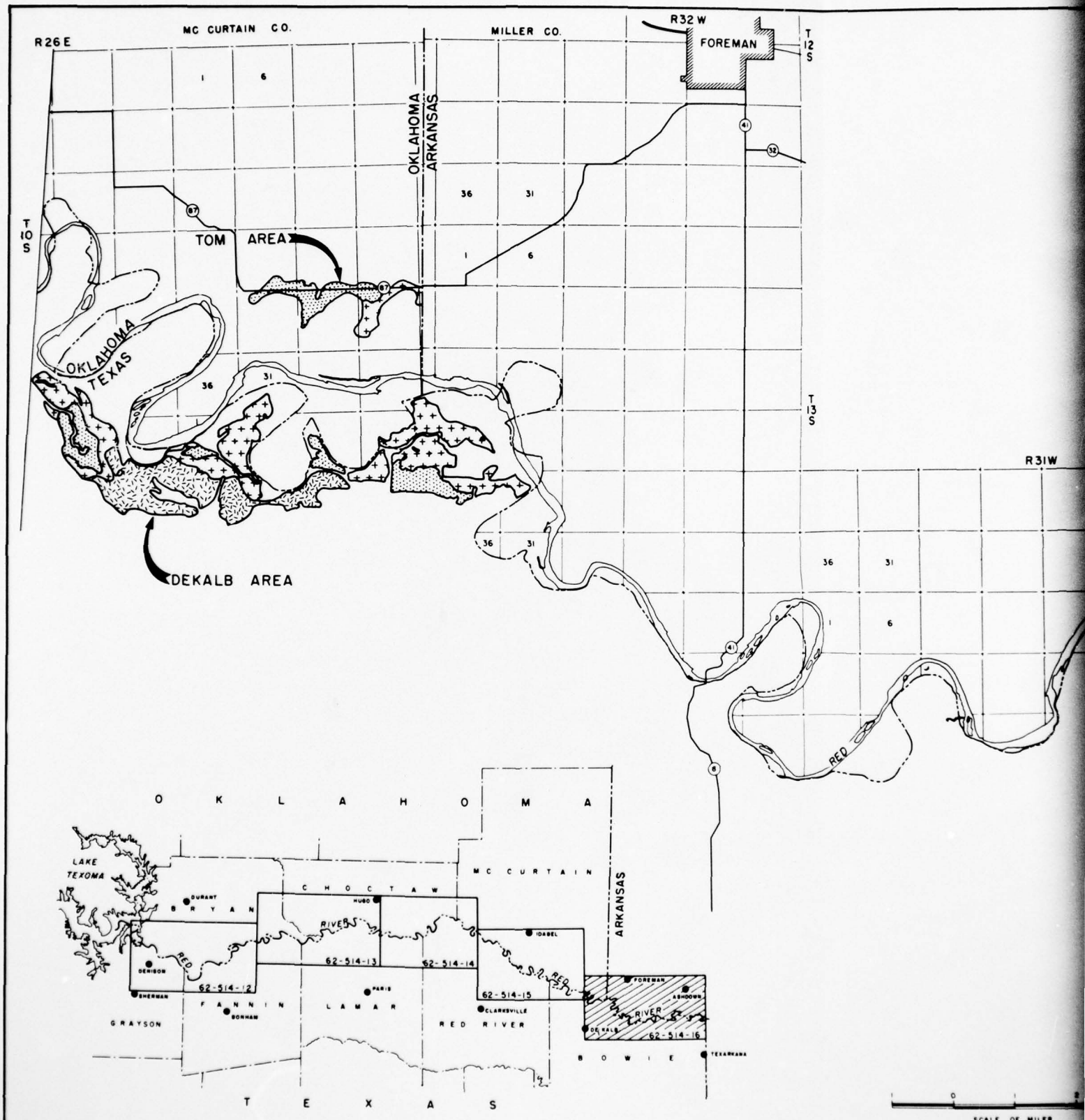
- Class 1 Arable Land
- Class 2 Arable Land
- Class 3 Arable Land
- Potential Sprinkler Irrigation
- Potential Rice Land

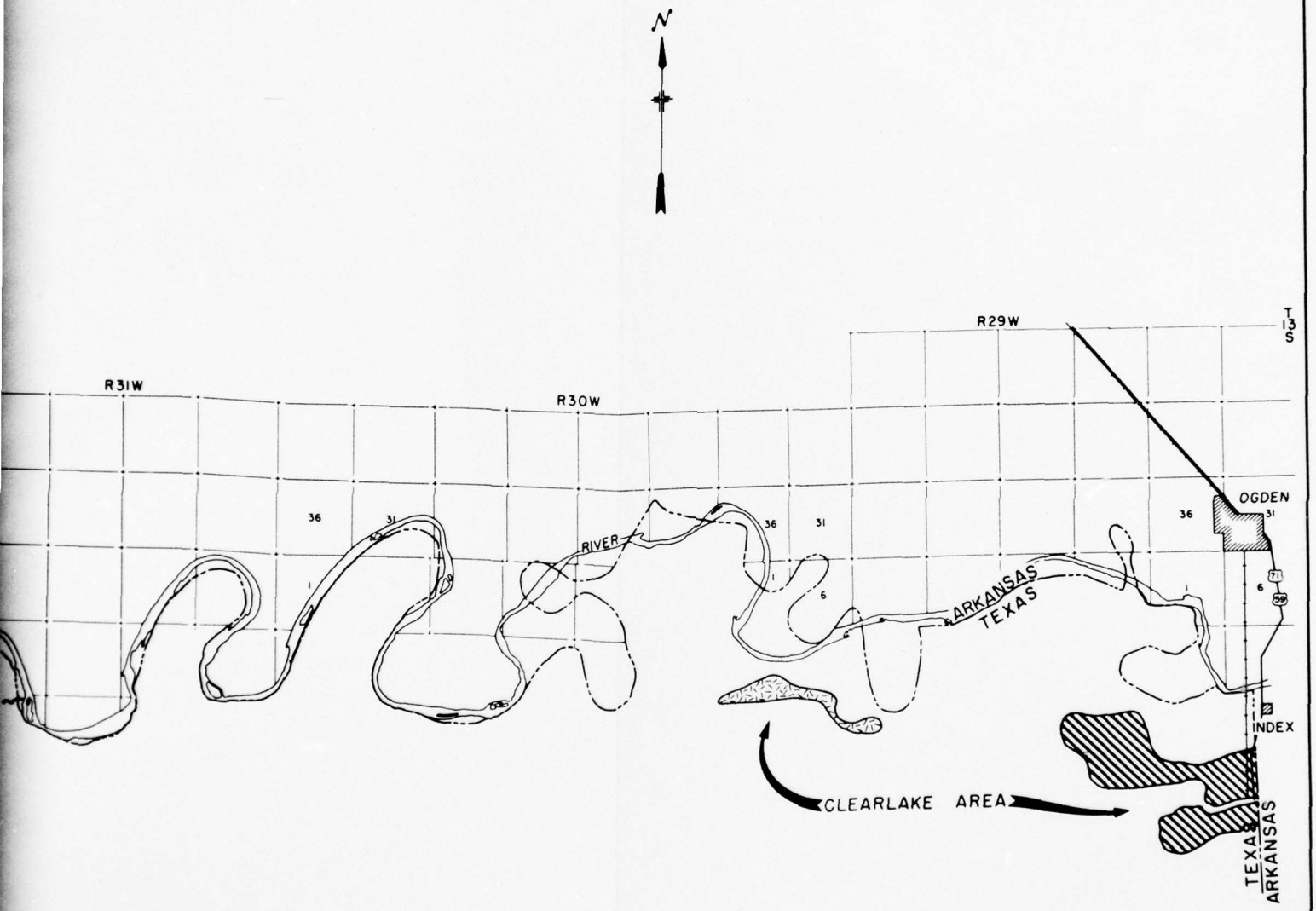
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA - TEXAS

LAND CLASSIFICATION

OKLAHOMA CITY, OKLA NOV 1965 62-514-15

2


R26E
MC CURTAIN CO.
MILLER CO.
R32W
FOREMAN
T 12 S
OKLAHOMA
ARKANSAS
T 10 S
TOM AREA
OKLAHOMA
TEXAS
T 13 S
R31W
DEKALB AREA
RED
OKLAHOMA
LAKE TEXOMA
MC CURTAIN
CHOCTAW
BRYAN
DURANT
HUGO
IDABEL
ARKANSAS
RIVER
RED
DENISON
62-514-13
62-514-14
62-514-12
62-514-15
62-514-16
SHERMAN
PARIS
FOREMAN
ASHDOWN
FANNIN
LAMAR
BONHAM
CLARKSVILLE
DE KALB
GRAYSON
RED RIVER
BOWIE
TEXARKANA
TEXAS
SCALE OF MILES



EXPLANATION

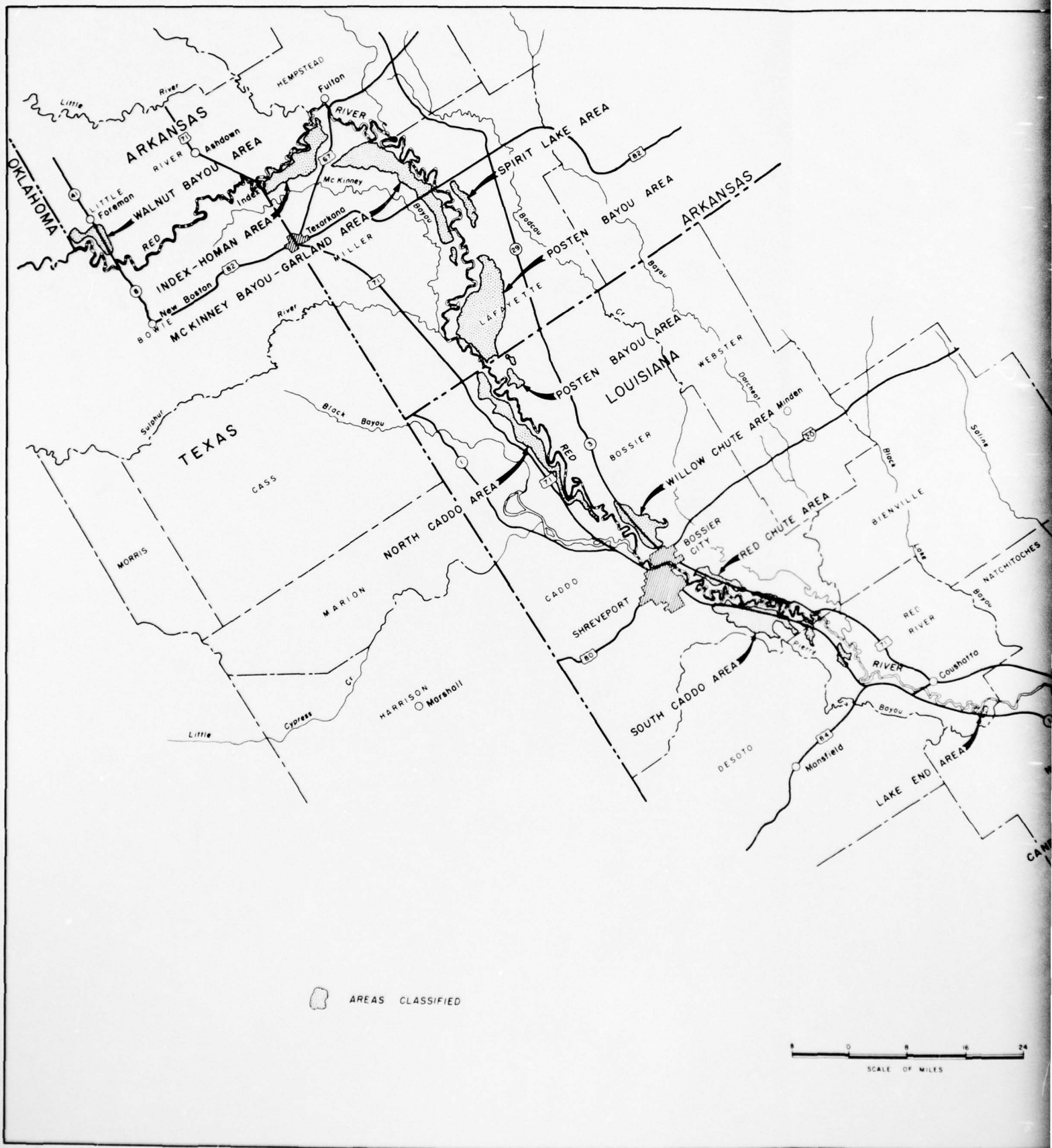
- Class 1 Arable Land
- Class 2 Arable Land
- Class 3 Arable Land
- Potential Sprinkler Irrigation
- Potential Rice Land

SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
OKLAHOMA - TEXAS

LAND CLASSIFICATION

OKLAHOMA CITY, OKLA. NOV 1965 62-514-16


OKLAHOMA
ARKANSAS
TEXAS
LOUISIANA
Little River
HEMPSTEAD
Fulton
RIVER
Ashdown
WALNUT BAYOU AREA
LITTLE
Foreman
RED
INDEX-HOMAN AREA
Texarkana
MILLER
BOWIE
New Boston
McKINNEY BAYOU-GARLAND AREA
SPIRIT LAKE AREA
POSTEN BAYOU AREA
ARKANSAS
Bodcau Bayou
LAFAYETTE
POSTEN BAYOU AREA
LOUISIANA
WEBSTER
Dorcheat
Minden
WILLOW CHUTE AREA
Sulphur
Black Bayou
CASS
BOSSIER
NORTH CADDO AREA
BOSSIER CITY
RED CHUTE AREA
BIENVILLE
Saline
Black
Lake
NATCHITOCHES
MORRIS
MARION
CADDO
SHREVEPORT
RED RIVER
Bayou Pierre
Coushatta
SOUTH CADDO AREA
HARRISON
Marshall
Cypress Ck.
Little
DESOTO
Mansfield
LAKE END AREA
AREAS CLASSIFIED
SCALE OF MILES

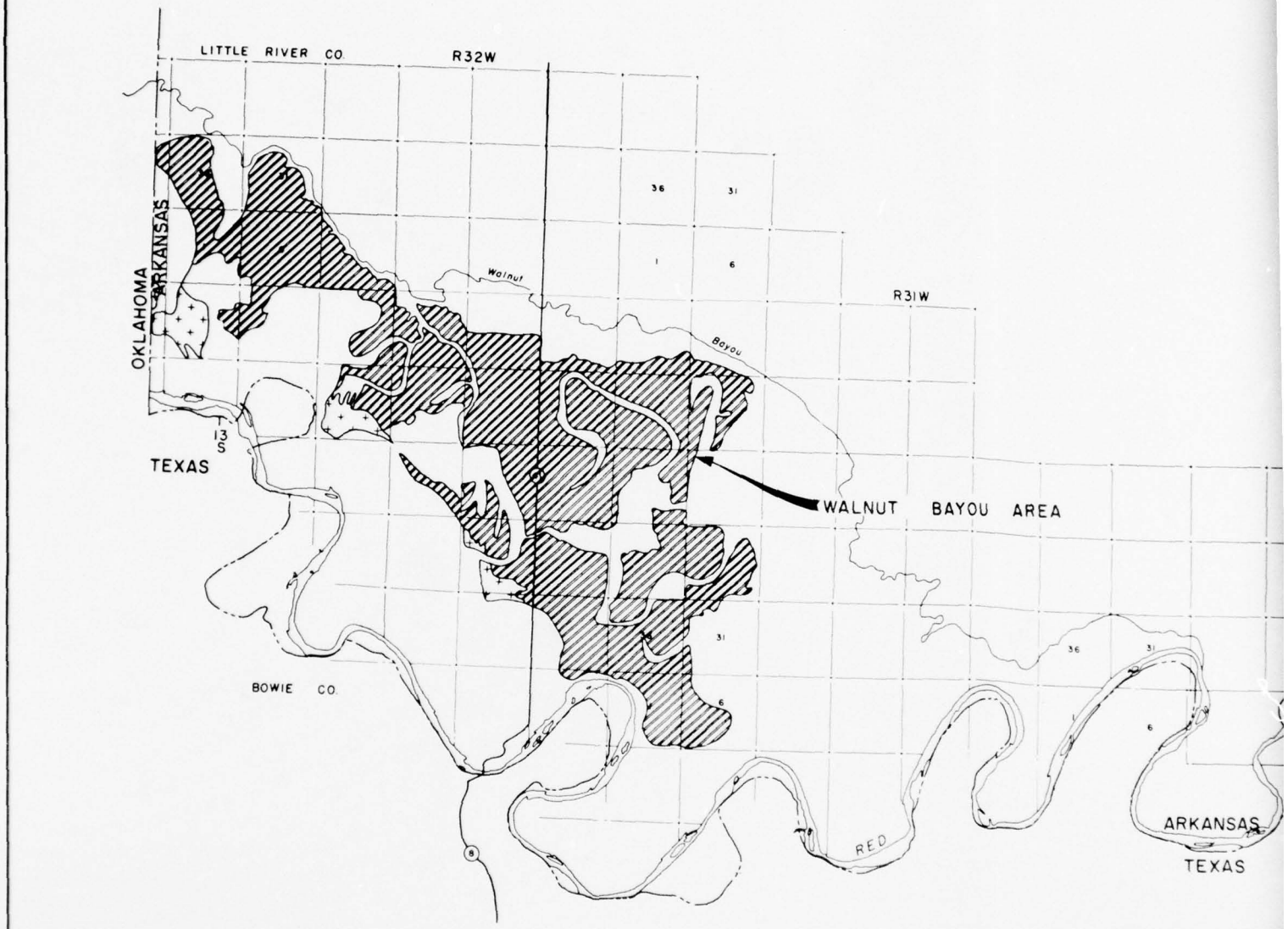
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA

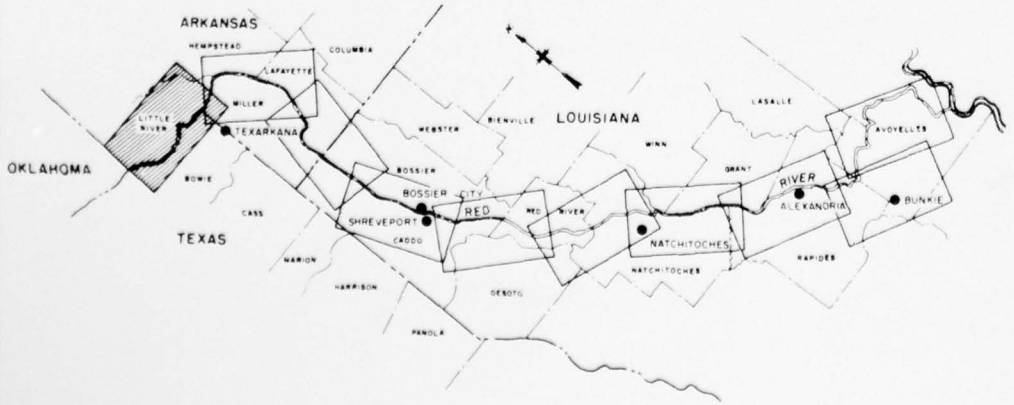
GENERAL MAP

OKLAHOMA CITY, OKLA OCT 1966

62-514-157

2





SCALE OF MILES

INDEX-HOMAN AREA

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA

LAND CLASSIFICATION

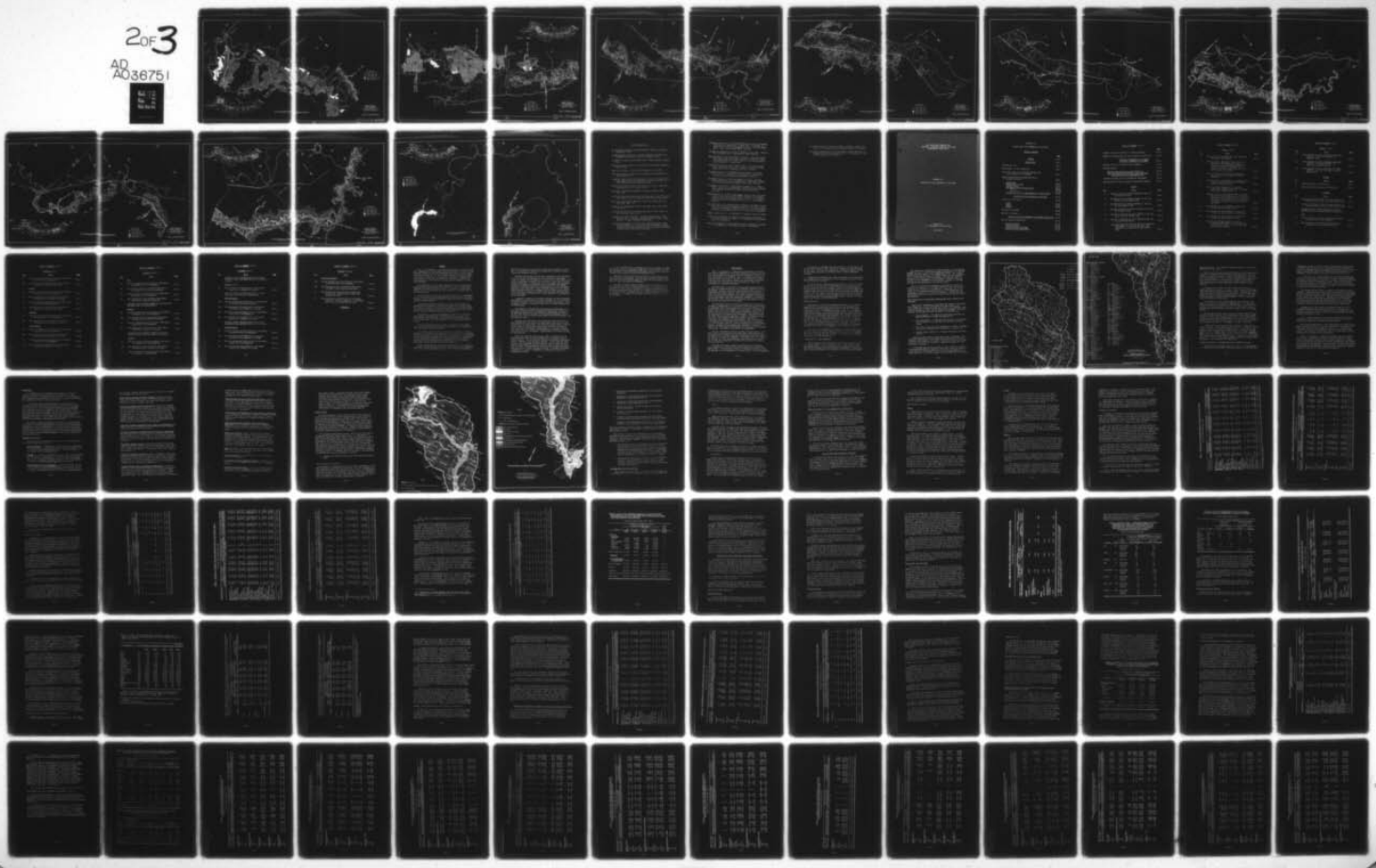
OKLAHOMA CITY, OKLA OCT 1966

62-514-158

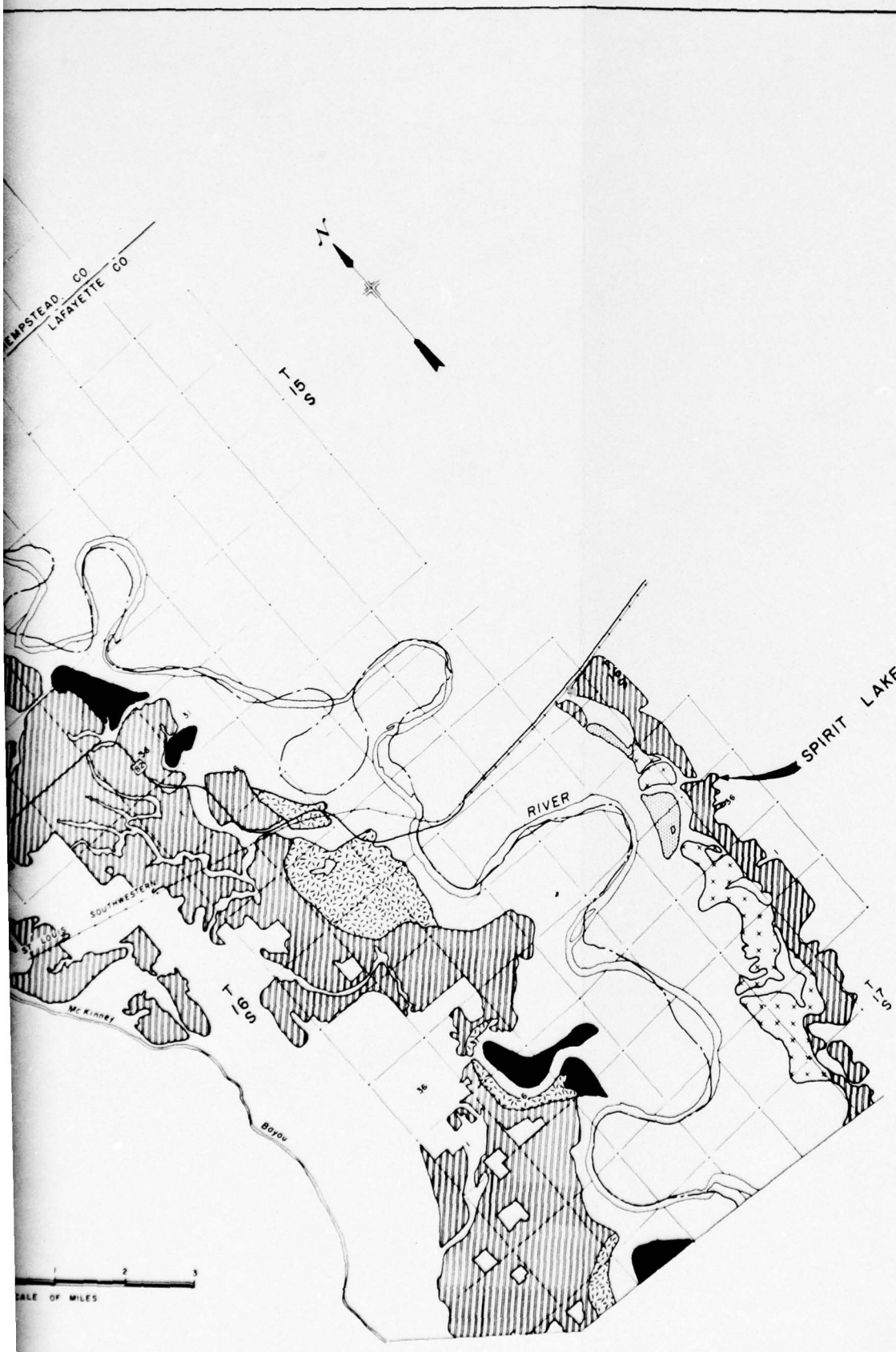
AD-A036 751 RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA F/G 8/6
COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSA--ETC(U)
JUN 68

UNCLASSIFIED NL

2 OF 3
AD A036751




T 13 S
R 26 W
R 25 W
R 27 W
FULTON
HEMPSTEAD CO.
LITTLE RIVER
RED RIVER
MO. PAC.
LITTLE RIVER CO.
MILLER CO.
RED
HEMPSTEAD CO
LAFAYETTE CO
INDEX-HOMAN AREA
HOMAN
T 14 S
T 13 S
SOUTHWESTERN
ST. LOUIS
McKINNEY
MC KINNEY BAYOU-
GARLAND AREA
ARKANSAS
HEMPSTEAD
LAFAYETTE
MILLER
COLUMBIA
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
CITY
SHREVEPORT
CADDO
RED RIVER
MARION
HARRISON
DESOTO
SABINE
NATCHITOCHES
RAPIDES
GRANT
LASALLE
AVOYELLES
ALEXANDRIA
RIVER
BUNKIE
SCALE OF MILES



EXPLANATION

- Class 1 Arable Land
- Class 2 Arable Land
- Class 3 Arable Land
- Potential Sprinkler Irrigation
- Potential Rice Land

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA

LAND CLASSIFICATION

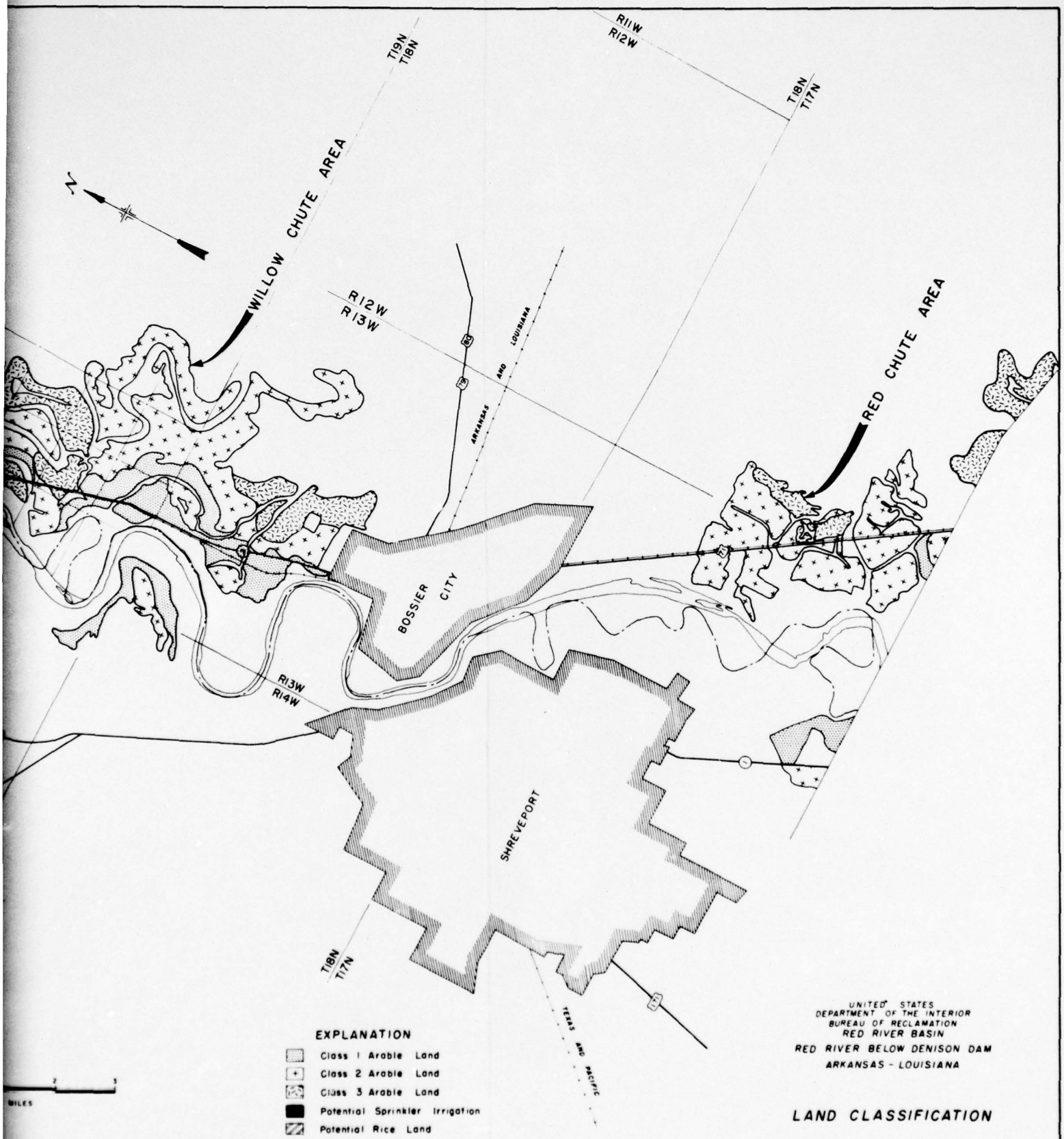
OKLAHOMA CITY, OKLA OCT 1966 62-514-159


R25W
MC KINNEY BAYOU-
GARLAND AREA
R26W
MC KINNEY
BAYOU
R27W
T
18
S
SULPHUR
RIVER
RED
TEXAS & PACIFIC
T
19
S
POSTEN BAYOU AREA
SCALE OF MILES
0
2

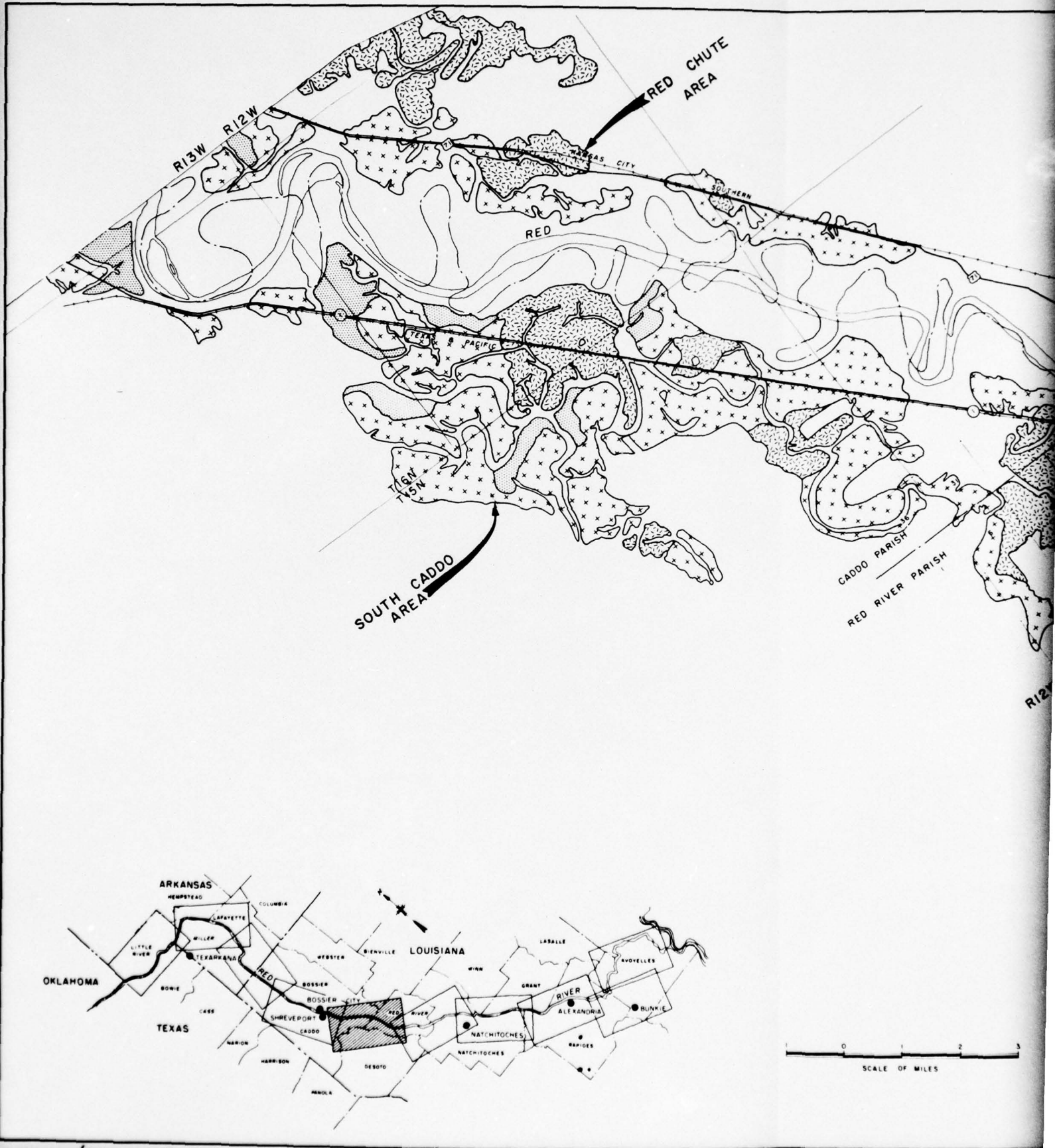

ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
BOSSIER CITY
RED RIVER
SHREVEPORT
CADDO
MARION
HARRISON
DESOTO
PANOLA
LASALLE
WINN
GRANT
AVOYELLES
RAPIDES
NATCHITOCHES
ALEXANDRIA
BUNKIE
N
ARKANSAS
LOUISIANA
BAYOU AREA
T 23 N
T 22 N
POSTEN
LAFAYETTE CO
BOSSIER PARISH
MILLER CO
CADDO PARISH
RED RIVER
R14W
HOSSTON
NORTH CADDO AREA
EXPLANATION
Class 1 Arable Land
Class 2 Arable Land
Class 3 Arable Land
Potential Sprinkler Irrigation
Potential Rice Land
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA
LAND CLASSIFICATION
OKLAHOMA CITY, OKLA OCT 1966
62-514-160

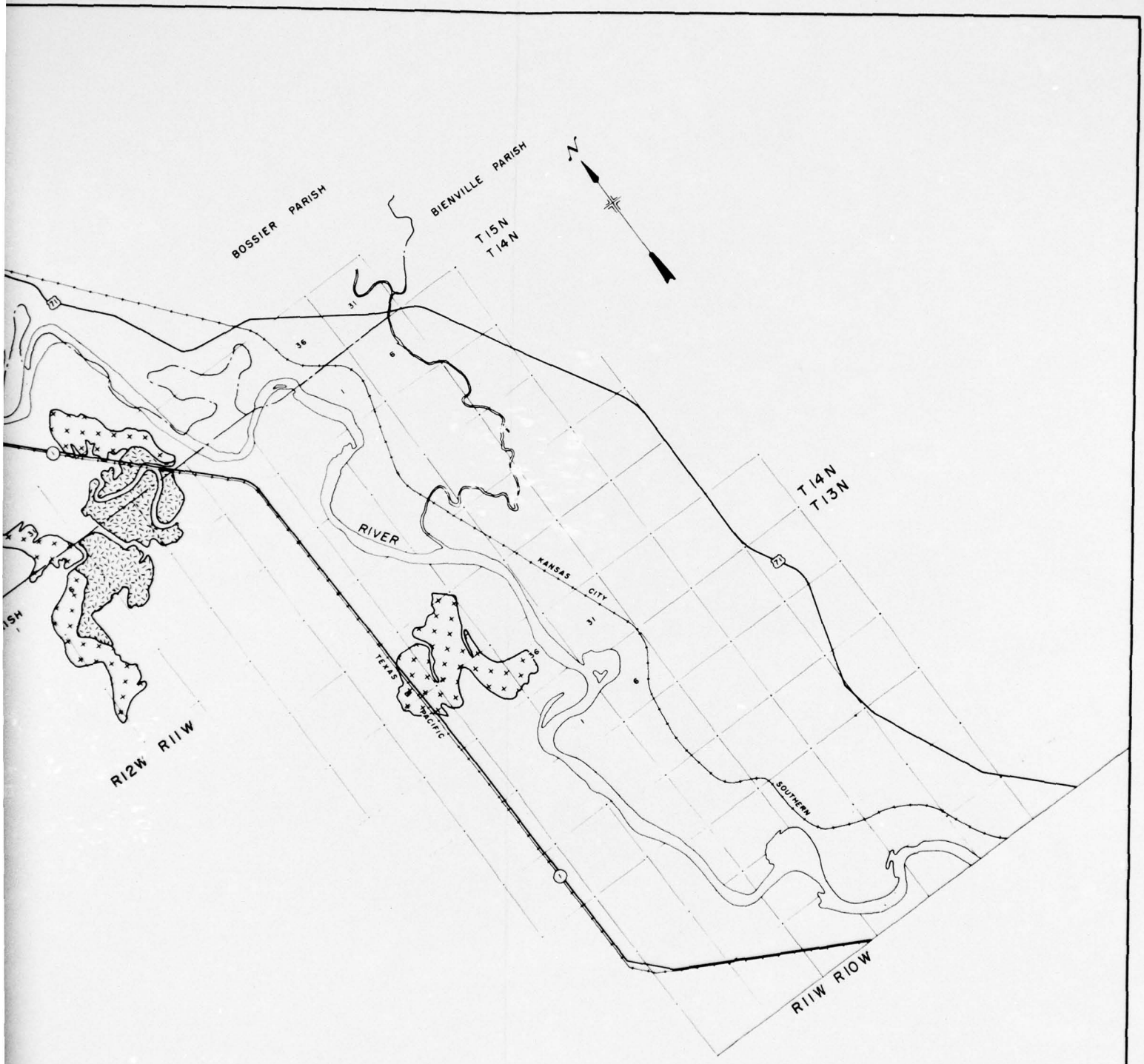
2


T21N
T20N
T20N
T19N
ST LOUIS
SOUTHWESTERN
BENTON
RED
RIVER
NORTH CADDO
AREA
T21N
T20N
ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE
RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
BOSSIER CITY
SHREVEPORT
CADDO
RED
RED RIVER
MARION
HARRISON
DESOTO
SABINE
WINN
LASALLE
GRANT
NATCHITOCHES
NATCHITOCHES
RAPIDES
RIVER
ALEXANDRIA
AVOYELLES
BUNKIE
SCALE OF MILES


T19N
T18N
R11W
R12W
T18N
T17N
N
WILLOW CHUTE AREA
R12W
R13W
89
ARKANSAS AND LOUISIANA
RED CHUTE AREA
BOSSIER CITY
R13W
R14W
SHREVEPORT
T18N
T17N
TEXAS AND PACIFIC
EXPLANATION
Class 1 Arable Land
Class 2 Arable Land
Class 3 Arable Land
Potential Sprinkler Irrigation
Potential Rice Land
2
3
MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA
LAND CLASSIFICATION
OKLAHOMA CITY, OKLA OCT 1966
62-514-161

2


RED CHUTE AREA
R13W
R12W
TEXAS & PACIFIC
KANSAS CITY SOUTHERN
RED
T16N
T15N
SOUTH CADDO AREA
CADDO PARISH
RED RIVER PARISH
R12W
ARKANSAS
HEMPSTEAD
LAFAYETTE
COLUMBIA
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
RED
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
BOSSIER CITY
SHREVEPORT
CADDO
RED RIVER
NATCHITOCHES
WINN
LASALLE
GRANT
AVOYELLES
RIVER
ALEXANDRIA
BUNKIE
RAPIDES
HARRISON
DESOTO
SABINE
MARION
SCALE OF MILES



EXPLANATION

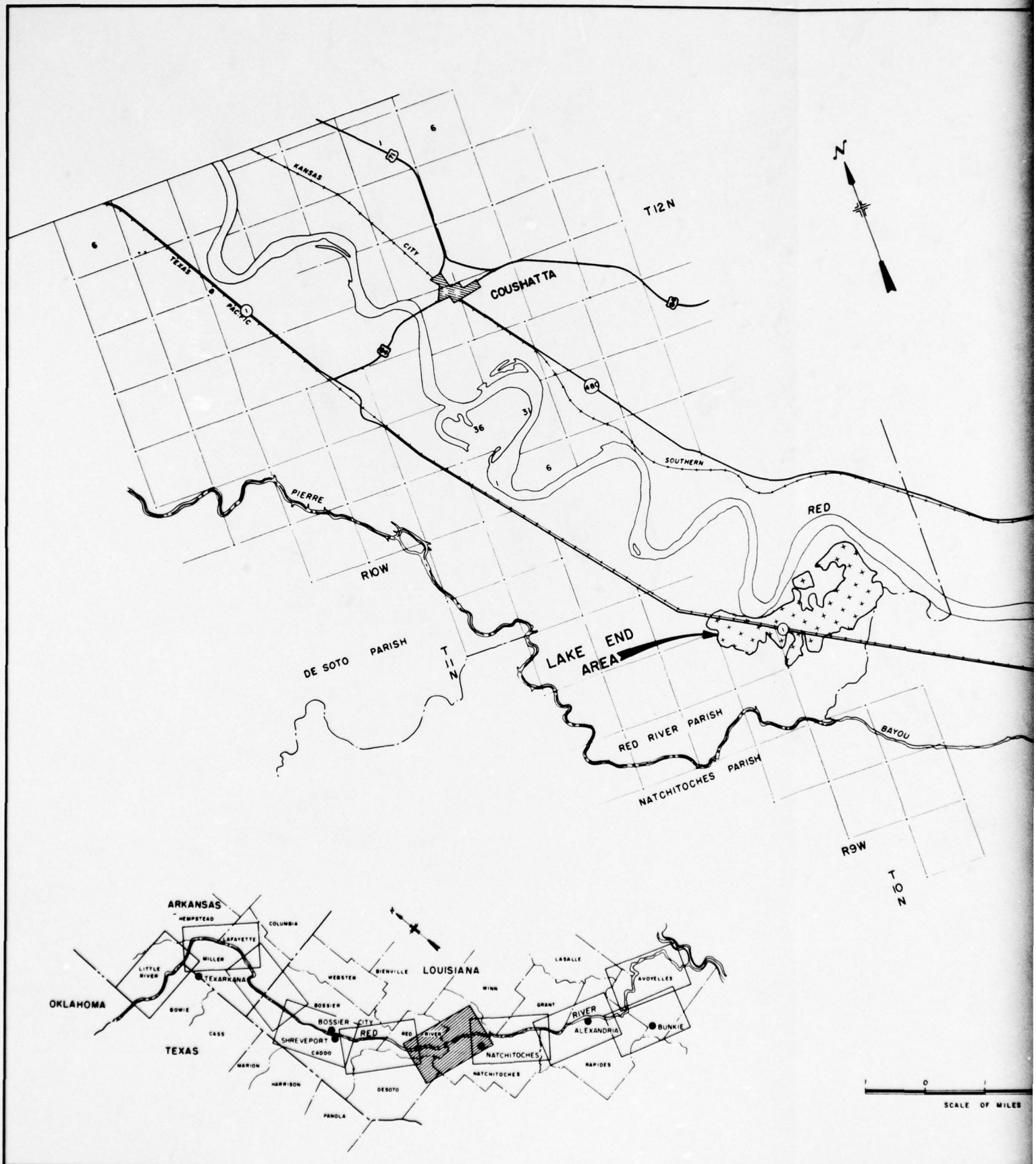
- Class 1 Arable Land
- Class 2 Arable Land
- Class 3 Arable Land
- Potential Sprinkler Irrigation
- Potential Rice Land

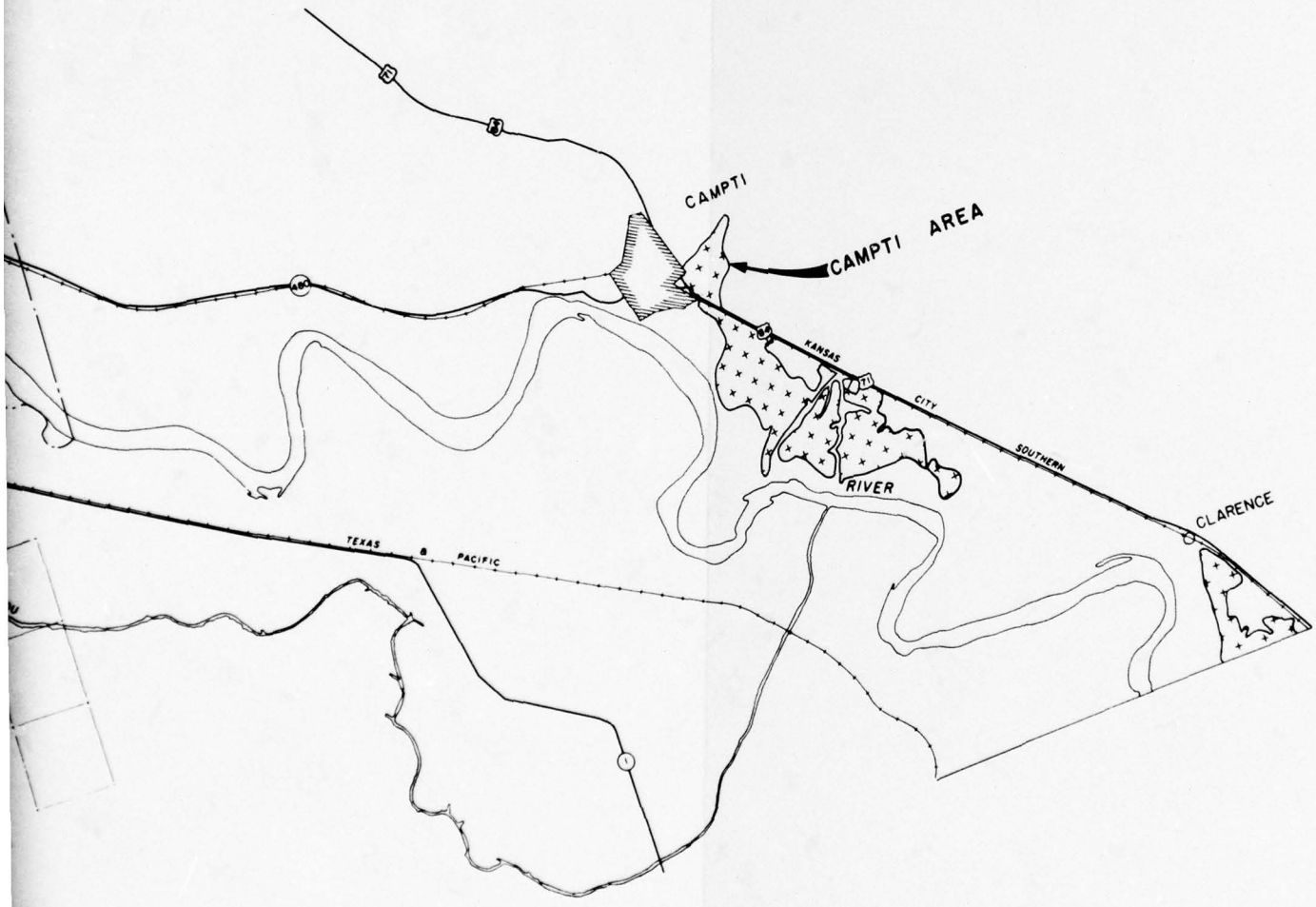
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA

LAND CLASSIFICATION

OKLAHOMA CITY, OKLA OCT 1966

62-514-162


KANSAS
CITY
TEXAS
PACIFIC
COUSHATTA
T12N
480
SOUTHERN
PIERRE
RIOW
RED
DE SOTO PARISH
T11N
LAKE END
AREA
RED RIVER PARISH
BAYOU
NATCHITOCHES PARISH
R9W
T10N
N
ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
WINN
LASALLE
AVOYELLES
GRANT
BOSSIER
BOSSIER CITY
SHREVEPORT
CADDO
RED
RIVER
NATCHITOCHES
ALEXANDRIA
BUNKIE
MARION
HARRISON
DESOTO
SABINE
RAPIDES
0
SCALE OF MILES



EXPLANATION

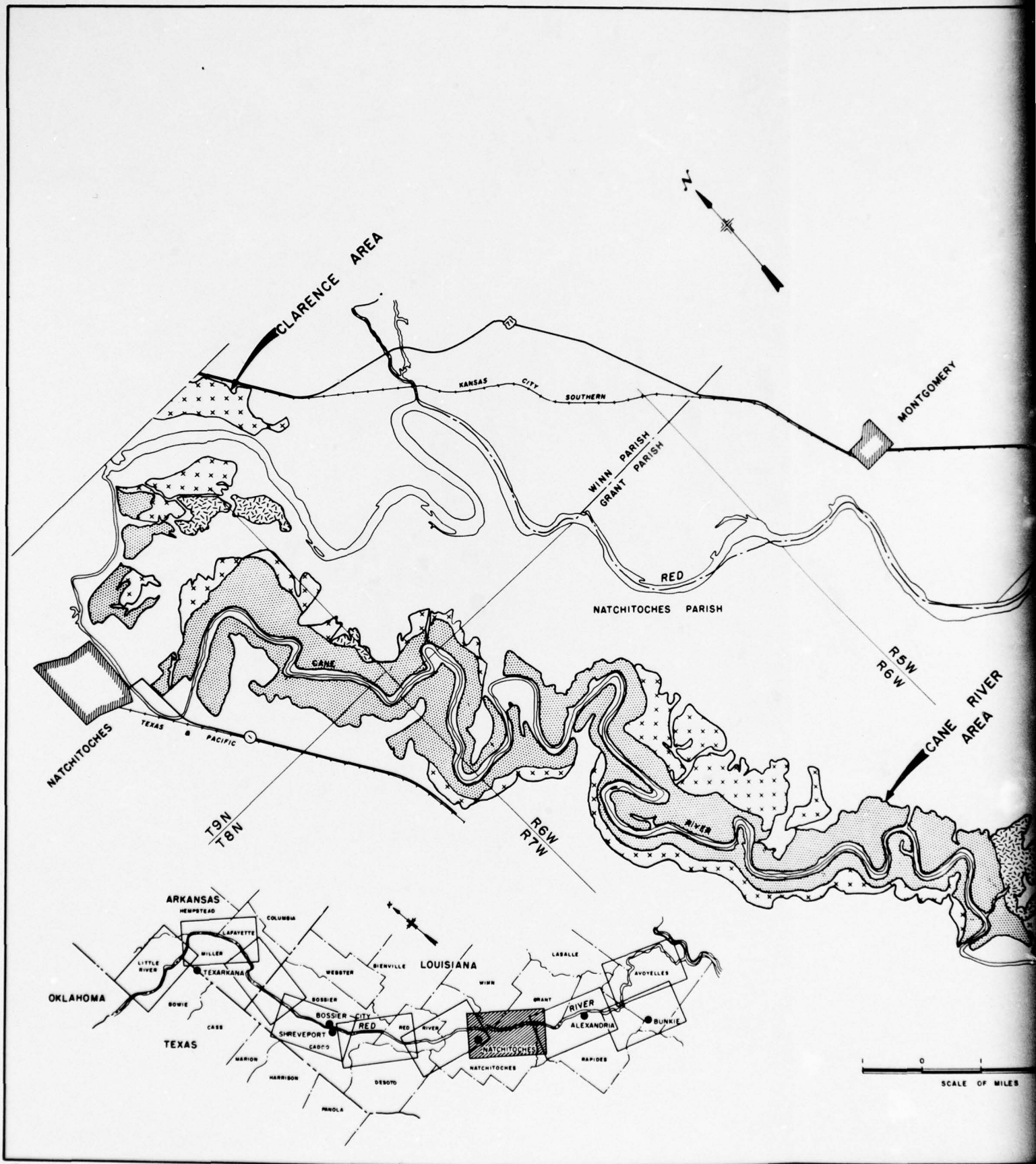
- Class 1 Arable Land
- Class 2 Arable Land
- Class 3 Arable Land
- Potential Sprinkler Irrigation
- Potential Rice Land

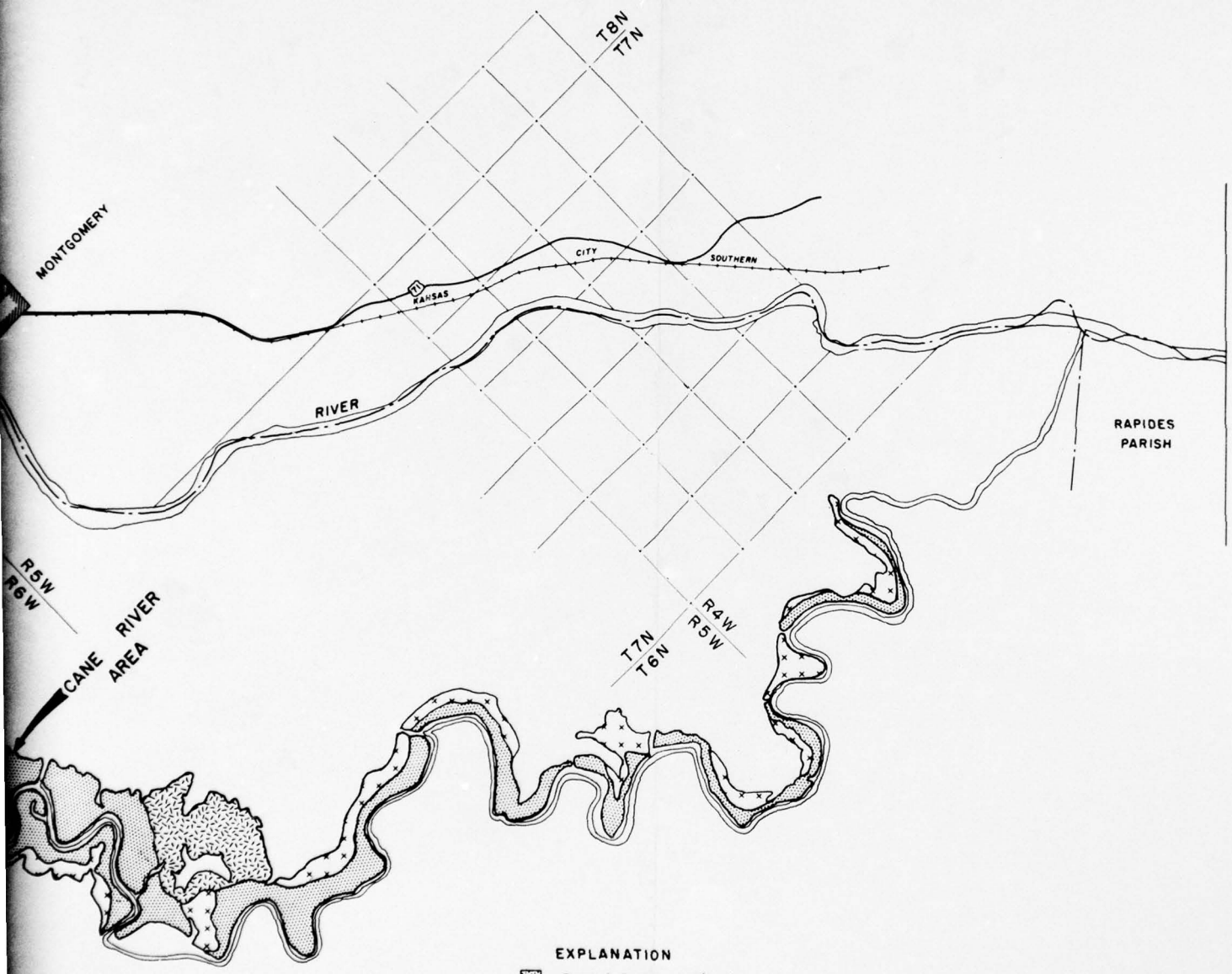
0 1 2 3
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA

LAND CLASSIFICATION

OKLAHOMA CITY, OKLA OCT 1966 62-514-163


CLARENCE AREA
71
KANSAS CITY SOUTHERN
MONTGOMERY
WINN PARISH
GRANT PARISH
RED
NATCHITOCHES PARISH
CANE
R5W
R6W
CANE RIVER AREA
NATCHITOCHES
TEXAS & PACIFIC
T9N
T8N
R6W
R7W
RIVER
ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
BOSSIER CITY
SHREVEPORT
RED
RED RIVER
CADDO
MARION
HARRISON
DESOTO
SABINE
WINN
LASALLE
GRANT
AVOYELLES
RIVER
ALEXANDRIA
BUNKIE
NATCHITOCHES
RAPIDES
1 0 1
SCALE OF MILES



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA

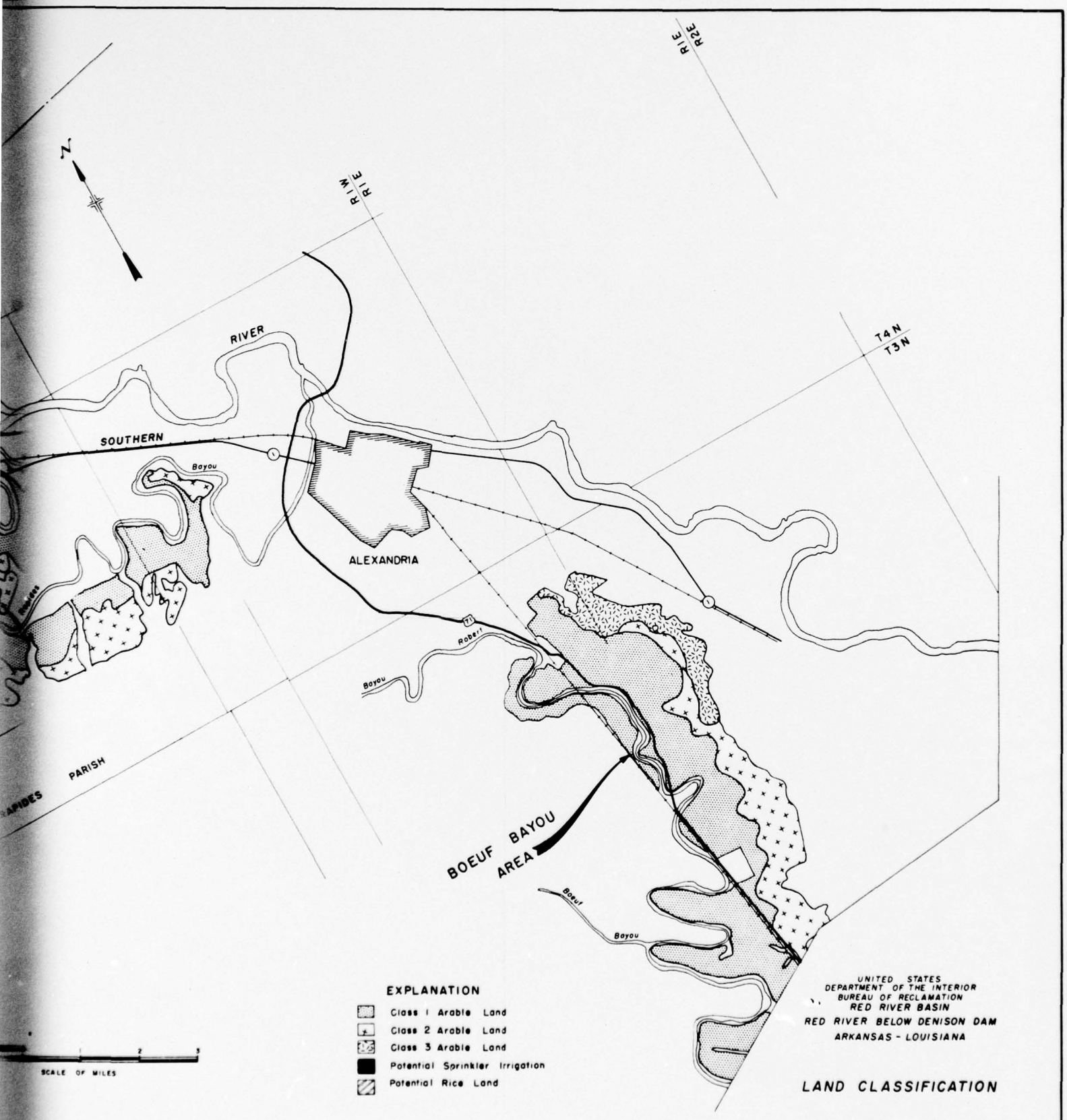
LAND CLASSIFICATION

OKLAHOMA CITY, OKLA. OCT 1966

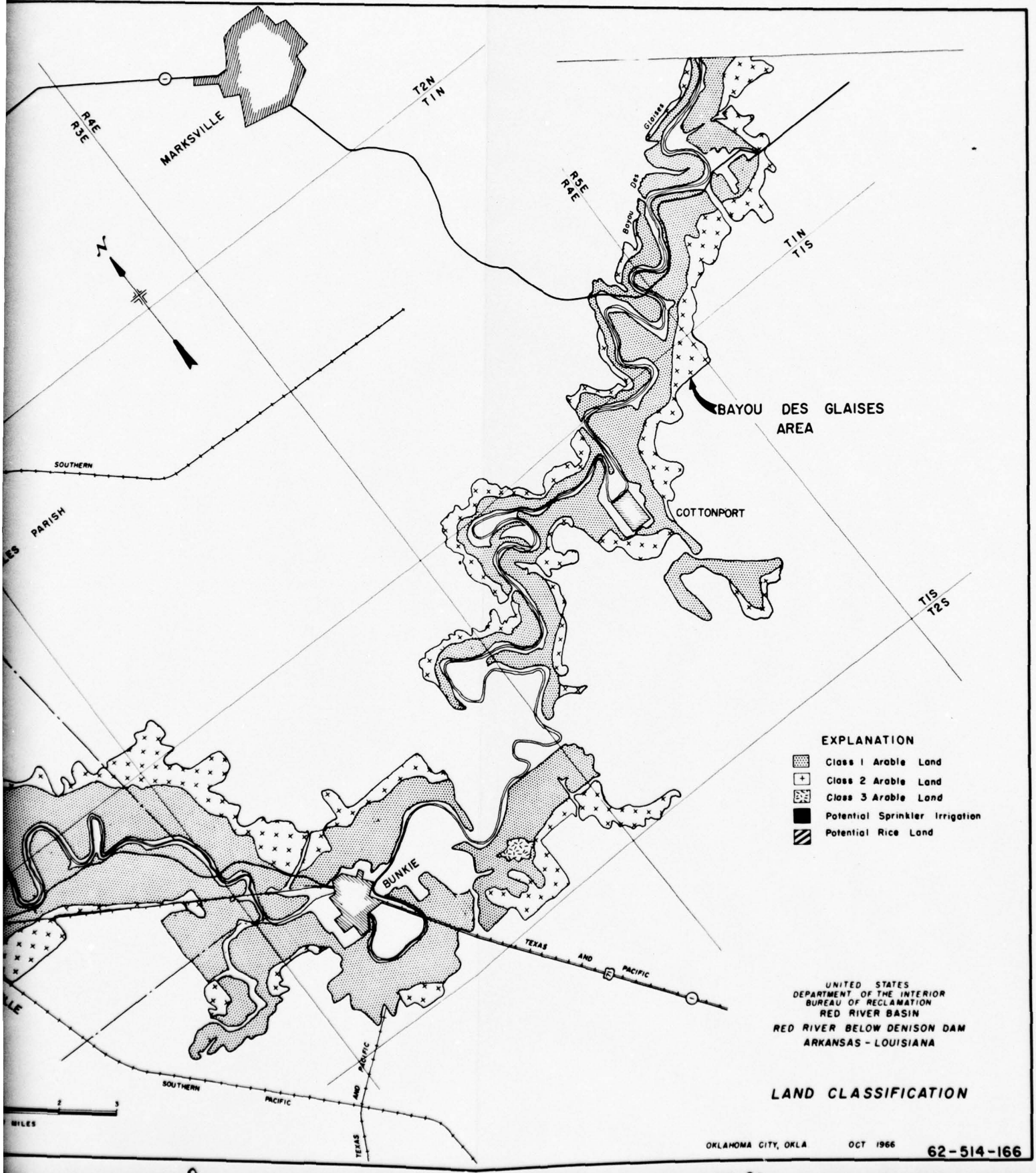
62-514-164

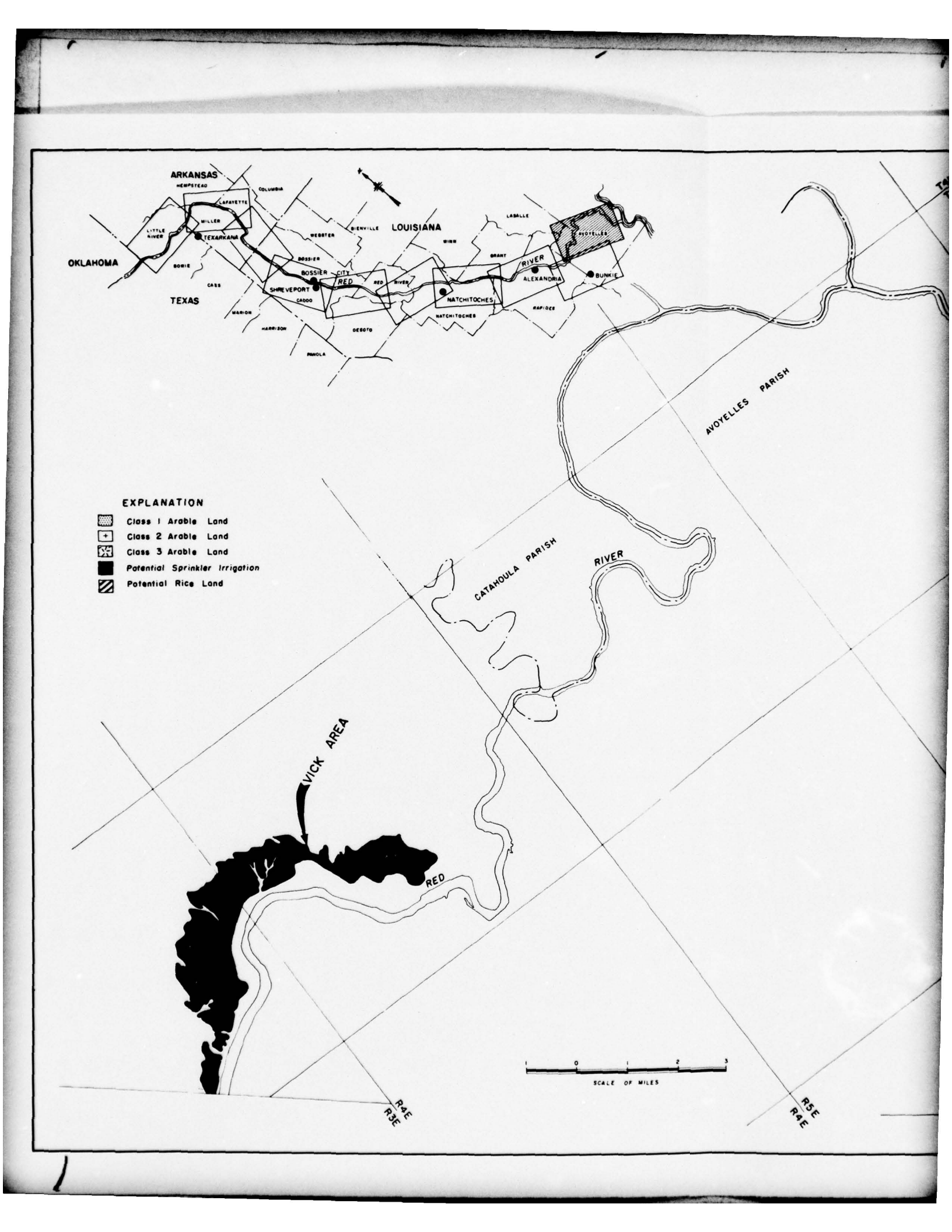
2

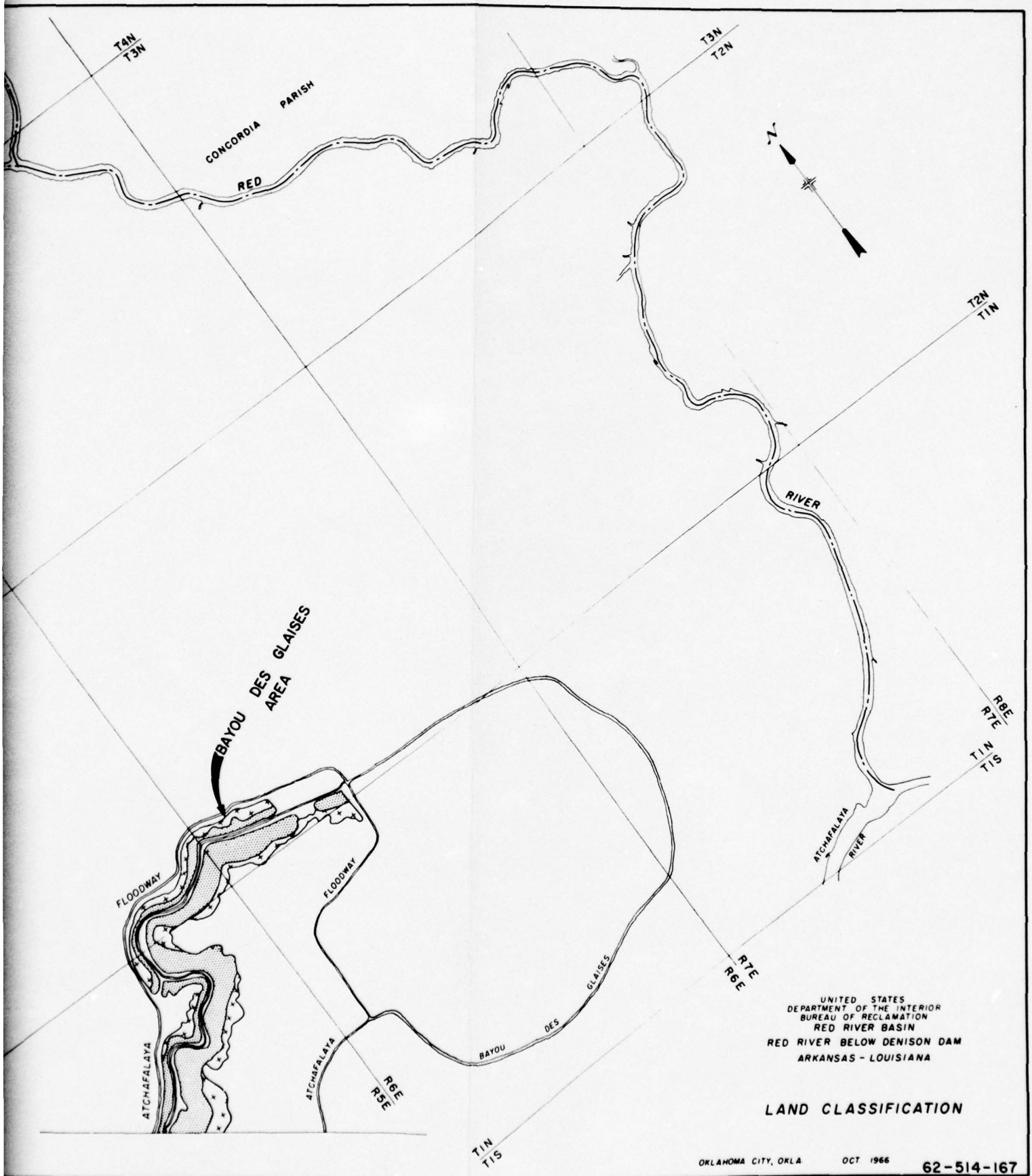

R3W
R2W
R1W
R4W
R5W
GRANT PARISH
RAPIDES PARISH
N
RED
SOUTHERN
CITY
KANSAS
T6N
T5N
BOYCE
RAPIDES BAYOU AREA
Rapides
RAPIDES PARISH
T5N
T4N
T4N
T3N
ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
CITY
SHREVEPORT
RED
RIVER
CADDO
MARION
HARRISON
DESOTO
PANOLA
WINN
LASALLE
GRANT
NATCHITOCHES
AVOYELLES
ALEXANDRIA
BUNKIE
RAPIDES
0
1
2
SCALE OF MILES


R1E
R2E
R1W
R1E
T4N
T3N
RIVER
SOUTHERN
Bayou
ALEXANDRIA
Bayou
PARISH
BOEUF BAYOU
AREA
Bayou
EXPLANATION
Class 1 Arable Land
Class 2 Arable Land
Class 3 Arable Land
Potential Sprinkler Irrigation
Potential Rice Land
SCALE OF MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA
LAND CLASSIFICATION
OKLAHOMA CITY, OKLA OCT. 1966
62-514-165


ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
BOSSIER CITY
RED RIVER
SHREVEPORT
CADDO
MARION
HARRISON
DESOTO
PANOLA
LASALLE
WINN
GRANT
AVOYELLES
RIVER
ALEXANDRIA
NATCHITOCHES
RAPIDES
R4E
R3E
R2E
R1E
RED RIVER
KANSAS CITY
SOUTHERN
AVOYELLES PARISH
RAPIDES PARISH
BOEUF BAYOU AREA
TEXAS AND PACIFIC
LECOMPTE
CHICAGO
ROCK ISLAND
AND
PACIFIC
Boeuf
Bayou
CHENEYVILLE
0
1
2
SCALE OF MILES


MARKSVILLE
T2N
T1N
R4E
R3E
R5E
R4E
BAYOU DES GLAISES
T1N
T1S
BAYOU DES GLAISES AREA
COTTONPORT
T1S
T2S
SOUTHERN
PARISH
BUNKIE
TEXAS AND PACIFIC
SOUTHERN PACIFIC
TEXAS AND PACIFIC
MILES
EXPLANATION
Class 1 Arable Land
Class 2 Arable Land
Class 3 Arable Land
Potential Sprinkler Irrigation
Potential Rice Land
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA
LAND CLASSIFICATION
OKLAHOMA CITY, OKLA OCT 1966
62-514-166


ARKANSAS
HEMPSTEAD
COLUMBIA
LAFAYETTE
MILLER
LITTLE RIVER
TEXARKANA
OKLAHOMA
BOWIE
CASS
TEXAS
WEBSTER
BIENVILLE
LOUISIANA
BOSSIER
BOSSIER CITY
SHREVEPORT
CADDO
RED RIVER
MARION
HARRISON
DESOTO
PANOLA
LASALLE
WINN
GRANT
NATCHITOCHES
RAPIDES
AVOYELLES
RIVER
ALEXANDRIA
BUNKIE
AVOYELLES PARISH
CATAHOULA PARISH
RIVER
EXPLANATION
Class 1 Arable Land
Class 2 Arable Land
Class 3 Arable Land
Potential Sprinkler Irrigation
Potential Rice Land
VICK AREA
RED
0
1
2
3
SCALE OF MILES
R4E
R3E
R5E
R4E


T4N
T3N
T3N
T2N
CONCORDIA PARISH
RED
N
T2N
T1N
RIVER
BAYOU DES GLAISES
AREA
R8E
R7E
T1N
T1S
ATCHAFALAYA
RIVER
FLOODWAY
FLOODWAY
R7E
R6E
BAYOU DES GLAISES
ATCHAFALAYA
R6E
R5E
T1N
T1S
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RED RIVER BASIN
RED RIVER BELOW DENISON DAM
ARKANSAS - LOUISIANA
LAND CLASSIFICATION
OKLAHOMA CITY, OKLA. OCT 1966
62-514-167

REFERENCES

Soil and Water Conservation Needs Inventory, Arkansas, Louisiana, Oklahoma, and Texas

Irrigation Guides, Arkansas, Louisiana, Oklahoma, and Texas, U. S. Department of Agriculture, Soil Conservation Service

Irrigation in Texas in 1958, Texas Board of Water Engineers Bulletin 6018

Inventory of Texas Irrigation 1958 and 1964, Texas Water Commission Bulletin 6515

Water Law in Arkansas, University of Arkansas, October 1963

Some Legal Aspects of Water Use in Louisiana, Louisiana State University Bulletin 537

Drought and Water Surplus in Agricultural Soils of the Lower Mississippi Valley Area, C.H.M. Van Bavel, Technical Bulletin No. 1209, USDA, Agricultural Research Service

Quality Water Control Study, Survey Report on, Corps of Engineers, Tulsa District, Vol. 1, part I, 1965

Work Plan, Cypress-Black Watershed, Louisiana, November 1965, USDA - SCS

Work Plan, Bayou Boeuf Watershed, Louisiana, April 1965, USDA - SCS, Forest Service, and the Louisiana Department of Public Works

Work Plan, Bayou Rapides Watershed, Louisiana, January 1960 and Supplements USDA - SCS

Diagnosis and Improvement of Saline and Alkali Soils, USDA, Handbook No. 60

Red River Below Denison Dam Comprehensive Basin Study, Survey of, USDA, Red River Basin Office

Geology of the Lower Red River. Technical Memorandum No. 3-319, September 1950 - Waterways Experiment Station, Corps of Engineers, U. S. Army, Vicksburg, Mississippi

Geology and Groundwater Resources of the Alexandria Area. Water Resources Pamphlet No. 3, November 1955 - Department of Conservation, Louisiana Geological Survey and Louisiana Department of Public Works, Baton Rouge, Louisiana

Groundwater Resources of the Red River Valley Alluvium in Louisiana, Water Resources Pamphlet No. 7, April 1960 - Department of Conservation, Louisiana Geological Survey and Louisiana Department of Public Works, Baton Rouge, Louisiana

Geology and Groundwater Resources of Grayson County, Texas. Bulletin 6013; September 1960 - Texas Board of Water Engineers

Water Resources of Red River Parish, Louisiana. Geological Survey Water Supply Paper 1614, 1962 - Prepared in Cooperation with Louisiana Department of Public Works and Louisiana Geological Survey Department of Conservation

Groundwater Geology of Grayson County, Texas. Geological Survey Water Supply Paper 1646, 1963 - Prepared in Cooperation with Texas Board of Water Engineers and City of Sherman

Groundwater Resources of Rapides Parish, Louisiana. Geological Bulletin No. 17, January 1940 - Department of Conservation, Louisiana Geological Survey, New Orleans, Louisiana

Groundwater Resources of Grant and LaSalle Parishes, Louisiana. Geological Bulletin No. 20, August 1941 - Department of Minerals, Louisiana Geological Survey, Baton Rouge, Louisiana

Groundwater in Louisiana. Water Resource Pamphlet No. 1, August 1960 - Department of Conservation, Louisiana Geological Survey and Louisiana Department of Public Works, Baton Rouge, Louisiana

Water Resources of the Blue, Muddy Boggy, Kiamichi, and Little River Basins in the Lower Red River Valley, Arkansas and Oklahoma. Reconnaissance Investigation Number 1, 1965, U. S. Geological Survey - Prepared in Cooperation with the U. S. Army Corps of Engineers

Water Resources of the Sulphur River and Cypress Creek Basins in the Lower Red River Valley, Arkansas, Louisiana, and Texas. Reconnaissance Investigation Number 2, 1966, U. S. Geological Survey - Prepared in Cooperation with the U. S. Army Corps of Engineers

Census of Agriculture, U. S. Department of Commerce, Bureau of Census

Irrigation Investigations for Red River Below Denison Dam (Part 1) Oklahoma and Texas, July 1966, U. S. Department of the Interior, Bureau of Reclamation

Plan of Development for Liberty Bottoms Project, Oklahoma, June 1963 - U. S. Department of the Interior, Bureau of Reclamation

Reconnaissance Report on Goodland Project, Oklahoma - Texas, June 1963 - U. S. Department of the Interior, Bureau of Reclamation

Irrigation Investigations for Red River Below Denison Dam (Part 2), Arkansas and Louisiana, January 1967 - U. S. Department of the Interior, Bureau of Reclamation

RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
COMPREHENSIVE BASIN STUDY

APPENDIX VII

DRAINAGE AND FLOOD PREVENTION ON FLATLANDS

Prepared by
U. S. Department of Agriculture

June 1968

APPENDIX VII

DRAINAGE AND FLOOD PREVENTION ON FLATLANDS

TABLE OF CONTENTS

	Page
SUMMARY	VII-1
INTRODUCTION	VII-4
PURPOSE AND SCOPE	VII-5
RELATIONSHIP TO OTHER APPENDICES	VII-5
BASIC PRINCIPLES OF AGRICULTURAL DRAINAGE AND FLOOD PREVENTION ON FLATLANDS	VII-6
GENERAL DESCRIPTION OF DRAINAGE AND FLOOD PREVENTION STUDIES	VII-9
Methodology	VII-11
Explanation of Terms	VII-11
Source of Data	VII-14
Drainage and Flood Problem Scope	VII-17
Soils	VII-18
Agriculture	VII-18
Studies for the U. S. Army Engineers' Interim Report	VII-19
DRAINAGE AND FLOOD PROBLEM ON FLATLANDS	VII-19
DESCRIPTION OF PROBLEM	VII-20
Causes	VII-20
Extent	VII-21
Effects	VII-21
INVENTORY OF PROBLEM	VII-22
ANALYSIS OF PROBLEM	VII-25
DRAINAGE AND FLOOD PREVENTION DEVELOPMENT FEASIBILITY	VII-32
FACTORS AFFECTING FEASIBILITY	VII-32
Physical Factors	VII-32
Economic Factors	VII-33
Crop Yields and Technology	VII-34
Production Costs and Returns	VII-37

TABLE OF CONTENTS (cont'd)

	Page
DRAINAGE AND FLOOD PREVENTION IN FOREST MANAGEMENT	VII-39
SUMMARY OF LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY	VII-43
APPRAISAL OF POTENTIAL FOR DRAINAGE AND FLOOD PREVENTION DEVELOPMENT	VII-44
DRAINAGE AND FLOOD PREVENTION OUTLET CHANNELS	VII-48
ECONOMIC FACTORS	VII-49
Benefits from Increases in Crop Production	VII-49
Production Responses Necessary to Cover Drainage and Flood Prevention Improvement Costs	VII-49
POTENTIAL DRAINAGE AND FLOOD PREVENTION DEVELOPMENT	VII-51
FARM DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL	VII-53

TABLES

No.	Title	Page
1	DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE AND TRIBUTARY BASIN	VII-23
1A	DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, STATE, AND LAND RESOURCE AREA	VII-24
1B	DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE AND LAND RESOURCE AREA	VII-26
2	ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE AND TRIBUTARY BASIN	VII-27
2A	ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, STATE, AND LAND RESOURCE AREA	VII-28
2B	ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE AND LAND RESOURCE AREA	VII-30
3	SOILS WITH INADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, BY LAND USE, AND MAJOR CROP DISTRIBUTION FOR THREE MAJOR LAND RESOURCE AREAS	VII-31

TABLE OF CONTENTS (cont'd)

TABLES (cont'd)

No.	Title	Page
4	PER ACRE COSTS OF DRAINAGE AND FLOOD PREVENTION IMPROVEMENT ON FLATLANDS	VII-35
5	AVERAGE YIELDS - INADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, AND ADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT CONDITIONS, WITH GOOD MANAGEMENT AND ADVANCED TECHNOLOGY, BLACKLANDS, ALLUVIUM-SILTY UPLANDS, AND UPLANDS	VII-36
6	PER ACRE YIELDS WITHOUT AND WITH DRAINAGE AND FLOOD PREVENTION IMPROVEMENT IN SELECTED WATERSHEDS	VII-37
7	PRODUCTION COSTS, NET RETURNS, AND INCREASES WITH DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, ADJUSTED NORMALIZED PRICES	VII-38
8	PRICES - ADJUSTED NORMALIZED FOR SPECIFIC COMMODITIES, ARKANSAS, LOUISIANA, OKLAHOMA, TEXAS, AND 4-STATE AVERAGE	VII-40
9	SUMMARY, PRODUCTION COSTS AND RETURNS - ADJUSTED NORMALIZED INCOME, EXPENSES, AND NET RETURNS, WITH AND WITHOUT DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, AND REDUCTION IN NET INCOME DUE TO INADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT	VII-41
10	LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE AND TRIBUTARY BASIN	VII-45
10A	LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, STATE, AND LAND RESOURCE AREA	VII-46
10B	LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE AND LAND RESOURCE AREA	VII-47
11	POTENTIAL NET RETURNS, DRAINAGE AND FLOOD PREVENTION IMPROVEMENT: CROPLAND HARVESTED AND PASTURED, BY MAJOR CROPS, SELECTED LAND RESOURCE AREA GROUPINGS	VII-50

TABLES (cont'd)

No.	Title	Page
12	GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL - 1980 AND LONG-TERM - BY TRIBUTARY BASIN	VII-52
12A	GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL - 1980 AND LONG-TERM - BY STATE AND LAND RESOURCE AREA	VII-54
12B	GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL - 1980 AND LONG-TERM - BY LAND RESOURCE AREA	VII-54

FIGURES

No.	Title	Page
1	TRIBUTARY BASINS, RED RIVER BASIN	VII-7
2	MAJOR LAND RESOURCE AREAS, RED RIVER BASIN	VII-15

EXHIBITS

No.	Title	Page
1	Drainage and Flood Problem Inventory by Land Use, Tributary Basin, State, and Land Resource Area	VII-55
2	Analysis of Drainage and Flood Problem by Land Use, Tributary Basin, State, and Land Resource Area	VII-62
	ESTIMATED ANNUAL ADJUSTED NORMALIZED COSTS AND RETURNS PER ACRE, RED RIVER BASIN, FOR PRODUCING -	
	Corn	
3A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-69
3B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-70

TABLE OF CONTENTS (cont'd)

EXHIBITS (cont'd)

No.	Title	Page
3C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-71
3D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-72
	Cotton	
4A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-73
4B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-74
4C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-75
4D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-76
	Soybeans	
5A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-77
5B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-78
	Grain Sorghum	
6A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-79
6B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-80
6C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-81
6D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-82

TABLE OF CONTENTS (cont'd)

EXHIBITS (cont'd)

No.	Title	Page
	Oats	
7A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-83
7B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-84
7C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-85
7D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-86
	ESTIMATED ANNUAL ADJUSTED NORMALIZED COSTS PER ACRE, RED RIVER BASIN, FOR ESTABLISHING -	
	Alfalfa	
8A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-87
8B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-88
8C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-89
8D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-90
	ESTIMATED ANNUAL ADJUSTED NORMALIZED COSTS AND RETURNS PER ACRE, RED RIVER BASIN, FOR PRODUCING -	
	Alfalfa	
9A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-91
9B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-92
9C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-93

EXHIBITS (cont'd)

No.	Title	Page
	ESTIMATED ANNUAL ADJUSTED NORMALIZED COSTS AND RETURNS PER ACRE, RED RIVER BASIN, FOR PRODUCING - (cont'd)	
	Alfalfa (cont'd)	
9D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-94
	ESTIMATED ANNUAL ADJUSTED NORMALIZED COSTS PER ACRE, RED RIVER BASIN, FOR ESTABLISHING -	
	Bermuda Pasture	
10A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-95
10B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-96
10C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-97
10D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-98
	ESTIMATED ANNUAL ADJUSTED NORMALIZED COSTS AND RETURNS PER ACRE, RED RIVER BASIN, FOR PRODUCING -	
	Bermuda Pasture	
11A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-99
11B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-100
11C	Without Drainage and Flood Prevention Improvement, Upland Soils, Good Management	VII-101
11D	With Drainage and Flood Prevention Improvement, Upland Soils, Advanced Technology	VII-102

TABLE OF CONTENTS (cont'd)

EXHIBITS (cont'd)

No.	Title	Page
	Services Lespedeza	
12A	Without Drainage and Flood Prevention Improvement, Bottomland Soils, Good Management	VII-103
12B	With Drainage and Flood Prevention Improvement, Bottomland Soils, Advanced Technology	VII-104
13	Land Drainage and Flood Prevention Feasibility by Land Use, Tributary Basin, State, and Land Resource Area	VII-105
14	Group Drainage and Flood Prevention Development Potential - 1980 and Long-term - by Tributary Basin, State, and Land Resource Area	VII-112
	REFERENCES	VII-116

SUMMARY

The U. S. Department of Agriculture participated in the Red River Basin Comprehensive Study under authority provided by Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended). The Act is administered by the Soil Conservation Service of the USDA. It authorizes the USDA to cooperate with other federal, state, and local groups or agencies in surveys and investigations of river basins as a basis for development of coordinated programs.

This appendix is one of three appendices that the USDA was assigned primary responsibility for preparing for the Red River Basin Comprehensive Study interagency report. It includes investigation results on only the drainage and flood problems on flatlands part of the investigations.

Flood prevention on flatlands is defined as works of improvement for the conveyance, control, and disposal of surface water caused by abnormally high, direct precipitation, runoff from higher elevations, and from stream overflow.

Drainage on flatlands is defined as works of improvement installed for the purpose of removing the excess water from the plant root zone of the soil or from the soil surface in areas where normal precipitation, seepage, or excess irrigation water keeps the soil too wet for the most economical agricultural production.

The purpose of this water management analysis, as it pertains specifically to drainage and flood prevention on flatland, is to identify and inventory these problem areas in the Red River Basin below Denison Dam. The Ouachita-Black River drainage area was excluded.

The USDA cooperated with the Corps of Engineers, New Orleans and Tulsa Districts, and state agencies in making this drainage and flood prevention study on flatlands.

The interest and activities in relation to drainage and flood problems in flatlands vary widely within the limits of the Study Area. Extensive projects have been constructed in the Arkansas and Louisiana portion of the basin complex, while very little has been constructed in the Oklahoma and Texas portion. Drainage and flood prevention activity in all states has been confined mostly to the Southern Mississippi Valley Alluvium Land Resource Area (131).

There are many factors that cause drainage and flood problems on flatlands, such as flat slopes, uneven land surface, slowly permeable soils, etc. The main physiological effect of inadequate drainage

and flood prevention on crop plants is the lack of aeration in the soil. Crop yields are reduced, and operations relating to crop production are adversely affected.

Physical and economic factors were considered in the development of soils feasible for drainage and flood prevention improvement. Costs and returns from drainage and flood prevention improvement, crop yields, technology, and production costs have a vital part in establishing feasibility. Cotton, hay, and corn acreages are the greatest affected by inadequate drainage and flood prevention improvement. Generally, woodland drainage for woodland benefit is not considered feasible in the Study Area. Forest drainage research in the Coastal Plain has shown benefits to drainage of wet pineland sites; however, these sites are so sparsely located within the Study Area that they are not included in the inventory of soils feasible for drainage and flood improvement.

In general, the effect of adequate drainage and flood prevention improvement on cropland has been found to result in: (1) An increase in harvested yields; (2) An increase in machinery efficiency; (3) An increase in quality of harvested crops; and (4) Greater adaptability of mechanization.

The purpose of drainage and flood prevention improvement is to keep soils productive with a corresponding minimum soil depletion. The greatest drainage and flood prevention improvement potential in the Red River Basin is located in the Southern Mississippi Valley Alluvium (131) and the Southern Mississippi Valley Silty Uplands (134) Land Resource Areas.

Benefits from increases in crop production expected to result from drainage and flood prevention improvements were limited to the increases in net crop income. The estimated average annual reduction in net income in the Red River Basin from inadequate drainage and flood prevention improvement is approximately 4.3 million dollars. This reduction in net income from cropland with inadequate drainage and flood prevention improvement is approximately 10 dollars per acre of land affected.

There are 4,822,400 acres of soils with a drainage and flood problem located within a total drainage and flood problem area of 5,407,400 acres. The 585,000-acre difference represents interspersed areas of permeable soils having no problem. Of the 4,822,400 acres of soils with a drainage and flood problem, 424,200 acres have had adequate improvements installed, leaving 4,398,200 acres remaining with a problem. Although 424,200 acres have been adequately drained, some may require further improvement because of improper maintenance or because of a change in standards for drainage as a result of changing agriculture.

Of the 4,398,200 acres of flatland soils with inadequate drainage and flood prevention improvement, there are 1,279,500 acres feasible for drainage and flood prevention improvement and 3,118,700 acres not feasible under normalized prices and projected needs.

There are 807,300 acres with a pctential for group drainage and flood prevention development. Of this total, there are 699,000 acres identified for potential development by 1980 and 108,300 acres identified for long-term potential development.

There are 1,279,500 acres considered to have a potential for on-farm drainage and flood prevention improvement. No attempt was made to divide the soils with a potential for on-farm drainage and flood prevention improvement into the 1980 and long-term potential acreages. It is expected that development of this on-farm potential will follow the pattern of development of the group potential since the two are interrelated.

INTRODUCTION

The U. S. Department of Agriculture participated in the Red River Basin Comprehensive Study under authority provided by Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended). The act is administered by the Soil Conservation Service of the USDA. It authorizes the USDA to cooperate with other Federal, State, and local groups or agencies in surveys and investigations of river basins as a basis for development of coordinated programs.

The USDA Study is necessary to develop agricultural data for the use of cooperating agencies and to prepare a potential plan of development for water and related land resources that could be accomplished under USDA programs. Agricultural data is needed by State and other Federal agencies as a basis for planning water and related land resource projects under their programs. A potential plan of development under USDA programs is needed for preparation and selection of an overall plan of potential development of water and related land resources in the basin.

The principal objectives of USDA participation in the Study included (1) preparation of a water and related land resources plan of development that would be harmonious with other elements of the overall basin plan of development, (2) development of information needed by State and other Federal planning agencies that could be used to evaluate potential improvements under their programs, and (3) opportunities for drawing upon information developed by State and other Federal planning agencies in order to establish a potential plan of development under USDA programs that would be coordinated with programs of other agencies. Objectives also include preparation of information for subsequent use in planning P. L. 566 watershed projects, resource conservation and development projects, programs for development and management of National Forests, and other USDA action programs for water and land resources conservation, development, utilization, and management.

The Soil Conservation Service, Economic Research Service, and Forest Service participated in the USDA study. Participation of each agency was coordinated through the Washington Advisory Committee and the Field Advisory Committee. The latter met on the call of the Chairman to effect coordination of USDA studies and to assure that studies were adequately coordinated with studies of other cooperating agencies.

The UDSA was assigned primary responsibility for preparing three appendices for the Red River Basin Comprehensive Study interagency report. This appendix includes investigation results on only the drainage and flood problems on flatlands part of the investigations.

The history of drainage and flood prevention on flatlands in the United States begins in 1835. The first handmade tile was installed in that year. The drain tile machine was invented in England in 1843 and soon after exported to the United States. Rapid development followed.

Large scale developments were made in surface ditch construction for drainage and flood prevention in the Mississippi alluvial valley during the period 1910-1927.

The 1959 Census of Agriculture shows more than 100 million acres of land in the United States in drainage and flood prevention projects serving agricultural flatlands. There are presently about 50 million acres of land in the United States that could be brought into increased agricultural production by improved drainage and flood prevention. Of this, there are 30 million in production and 20 million in new land. Thousands of acres of agricultural land have had adequate drainage and flood prevention improvements installed in recent years with Federal and State assistance.

PURPOSE AND SCOPE

The purpose of this water management analysis, as it pertains specifically to drainage and flood prevention on flatlands, is to identify and inventory these problem areas in the Red River Basin below Denison Dam. The analysis provides a means for considering comprehensive plans. It provides information which may be used in coordinating programs and projects planned and undertaken by Federal, State and local departments and agencies. The analysis attempts to evaluate the total average annual reduction in net incomes due to the drainage and flood problems which occur with present cropping patterns and farming conditions. Evaluation of benefits from specific projects is beyond the scope of this Appendix. Benefit evaluations for feasible projects will be included in the Upstream Watershed Protection, Use, Management, and Development appendix.

The scope of the Study Area includes the flatland areas in the Red River Basin below Denison Dam in Arkansas, Louisiana, Oklahoma, and Texas, where drainage and flooding is a problem. The Ouachita-Black River drainage area was excluded. The Study Area is divided into twenty-four tributary basins.

RELATIONSHIP TO OTHER APPENDICES

The Drainage and Flood Prevention on Flatlands appendix is one of fifteen appendices for the Red River Basin Comprehensive Study interagency report. It is concerned entirely with evaluation of agricultural drainage and flood problems and appraisal of potentials for alleviating problems in the flatlands of the Study Area (figure 1).

The importance of drainage and flood problems on flatlands and possible solutions to agriculture suggests preparation of a separate appendix for this aspect of the Comprehensive Study. The subject matter necessarily overlaps into subject matter of other appendices such as Flood Control and Major Drainage, and Upstream Watershed Protection, Use, Management, and Development. However, other appendices are not prepared for comprehensive treatment of drainage and related flood problems on all flatland areas.

Details of potential development in watersheds in which construction is expected to be initiated within the next 10-15 years (1980) are not included in this appendix. These data will be included in the Upstream Watershed Protection, Use, Management, and Development appendix for tributary watersheds. Similar data for major outlets will be included in the Flood Control and Major Drainage appendix.

BASIC PRINCIPLES OF AGRICULTURAL DRAINAGE AND FLOOD PREVENTION ON FLATLANDS

Agricultural drainage and flood prevention refers to the operations required to remove excess water from agricultural land. Excess water may be caused by high water table or by temporary flooding that prevents or limits use of conservation farming. Four main purposes for drainage and flood prevention on flatlands are:

1. Land reclamation - to bring into production land which at present produces no income from agriculture.

2. Land improvement - to increase production and to reduce the cost of production on land which is presently producing income.

3. Facilitate construction and maintenance of roads, railroads, urban areas (industrial and residential), airports, etc.

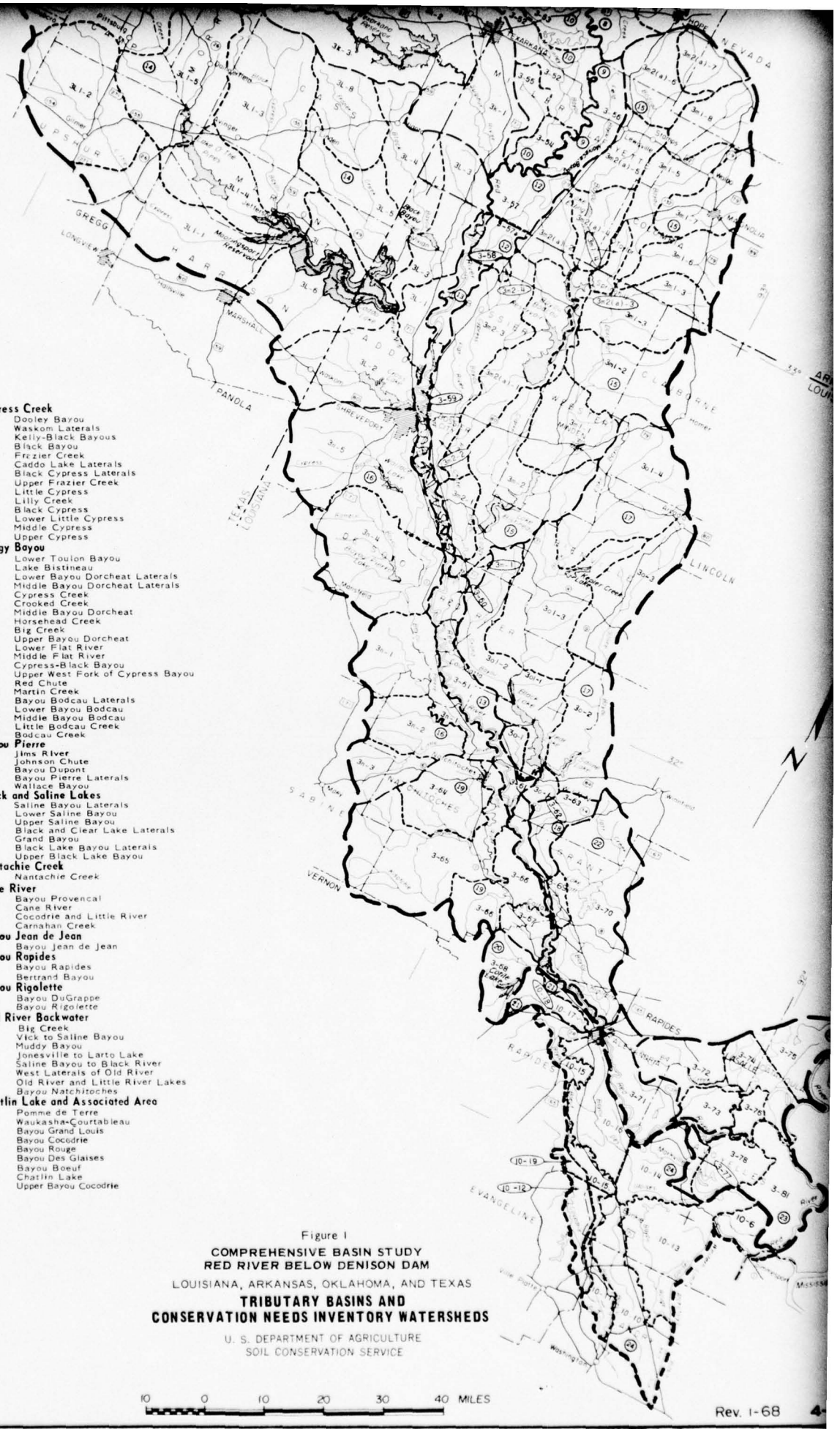
4. Improve health conditions - eliminate mosquitoes and other insects.

Crops must have sunshine, plant food, water, and oxygen. The essential requirements for the simultaneous availability of water, nutrients, and oxygen at the places of activity of the roots is the principal reason for the necessity of adequate drainage and flood prevention conditions.

For maximum agricultural production, water control is needed. Sufficient water must be supplied to the crop to meet its needs for plant growth while holding the elevation of the groundwater at a depth which will not inhibit proper root development and will permit


LEGEND
County Boundary
State Boundary
Existing Lakes Decemb
Reservoirs Authorized D
Comprehensive Study Ar
the River Basin Bounda
Basin Boundary
1
Tributary Basin
3hl-2
CNI Watershed Boundarie
VICINITY MAP
TRIBUTARY BASINS AND CNI WATERSHEDS
1 - Intervening Areas-Texas
3-18 Grayson Laterals
3-19 Choctaw Creek
3-20 Grayson-Fannin Laterals
3-21 Caney Creek
3-24 Fannin Laterals
3-25 Lower Bois d'Arc Creek
3-25a Upper Bois d'Arc Creek
3-27 Logan-Slough Creek
3-27a Upper Slough Creek
3-28 West Sanders Laterals
3-29 Chicota
3-30 Sanders Creek
3-31 East Sanders Laterals
3-33 Pine Creek
3-38 Big Pine Creek
3-42 Pecan Bayou
3-44 Red Bayou
2 - Intervening Areas-Arkansas and Oklahoma
3-22 Island Bayou
3-26 Whitegrass Creek
3-32 Choctaw Laterals
3-34 Valliant Laterals
3-35 McKinney-Buzzard
3-36 Whitegrass Waterhole
3-37 Perry Creek
3-39 Waterfall-Gilford
3-40 Norwood Creek
3-41 Walnut Bayou
3-43 Lower Walnut Bayou
14 - Cypress Creek
3L-1 Dooley Bayou

VICINITY MAP



TRIBUTARY BASINS AND CNI WATERSHEDS

1 - Intervening Areas-Texas

3-18 Grayson Laterals
3-19 Choctaw Creek
3-20 Grayson-Fannin Laterals
3-21 Caney Creek
3-24 Fannin Laterals
3-25 Lower Bois d'Arc Creek
3-25a Upper Bois d'Arc Creek
3-27 Logan-Slough Creek
3-27a Upper Slough Creek
3-28 West Sanders Laterals
3-29 Chicota
3-30 Sanders Creek
3-31 East Sanders Laterals
3-33 Pine Creek
3-38 Big Pine Creek
3-42 Pecan Bayou
3-44 Red Bayou

2 - Intervening Areas-Arkansas and Oklahoma

3-22 Island Bayou
3-26 Whitegrass Creek
3-32 Choctaw Laterals
3-34 Valliant Laterals
3-35 McKinney-Buzzard
3-36 Whitegrass Waterhole
3-37 Perry Creek
3-39 Waterfall-Gilford
3-40 Norwood Creek
3-41 Walnut Bayou
3-43 Lower Walnut Bayou
3-45 Bull Creek
3-46 Haney Creek
3-49 Cutoff Lakes

3 - Blue River

3-23a Upper Blue River
3-23 Lower Blue River

4 - Boggy Creek

3h-1 Boggy and Laterals
3h1-1 Boswell-Boggy
3h1-2 Lower Clear Boggy
3h1-3 Caney Creek
3h1-4 Delaware Creek
3h1-5 Leader-Middle Clear Boggy
3h1-6 Upper Clear Boggy
3h2-1 Lower Muddy Boggy
3h2-2 McGee Creek
3h2-3 North Boggy
3h2-4 Middle Muddy Boggy Creek
3h2-5 Caney-Coon Creek
3h2-6 Upper Muddy Boggy Creek

5 - Kiamichi River

3i-1 Lower Kiamichi
3i-2 Frogville
3i-3 Cedar Creek
3i-4 Dumpling-Beaver
3i-5 Buck Creek
3i-6 Jack Fork
3i-7 Upper Kiamichi River
3i-8 Rock Creek
3i-9 Buffalo Creek

6 - Barkman Creek

3-47 Ash Slough
3-48 Barkman Creek

7 - Little River

3j-1 Yellow Creek
3j-2 Lower Little River Laterals
3j-3 Lower Saline River
3j-4 Mine Creek
3j-5 Starch Creek
3j-6 Middle Saline River
3j-7 Upper Saline River
3j-8 Lick Creek
3j-9 Northbank Laterals of Little River
3j-10 Lower Cossatot River
3j-11 Middle Cossatot River
3j-12 Harris Creek
3j-13 Upper Cossatot River
3j-14 Caney-Flat Creek
3j-15 Lower Rolling Fork
3j-16 Upper Rolling Fork
3j-17 Lower Little River
3j-18 Lukfata Creek
3j-19 Glover Creek
3j-20 Middle Little River
3j-21 Upper Little River
3j1-1 Lower Mountain Fork
3j1-2 Middle Mountain Fork
3j1-3 Cove-Hatfield
3j1-4 Upper Mountain Fork
3j1-5 Potter

8 - Bois d'Arc Creek

3-50 Bridge Creek
3-51 Bois d'Arc Creek

9 - Maniece Bayou

3-56 Maniece Bayou

10 - McKinney Bayou

3-52 Upper McKinney Bayou
3-53 Buzzard Bluff
3-54 McKinney Bayou
3-55 Beech Creek

11 - Sulphur River

3k-1 Lower Sulphur River
3k-2 Big Creek
3k-3 Lower Sulphur Laterals
3k-4 Anderson Creek
3k-5 South Sulphur Laterals
3k-6 Cuthand Creek
3k-7 Sand Branch
3k-8 Langford Creek
3k-9 Bruton Creek
3k-10 Sand-Mustang Laterals
3k-11 Deport Area
3k-12 Click Creek
3k-13 Auds Creek
3k-14 Upper North Sulphur River
3k-15 Morgan Creek
3k-16 South Sulphur
3k-17 South Sulphur River, Middle Sulphur River & Pecan Creek
3k-18 Upper South Sulphur River
3k1-1 Lower White Oak Bayou
3k1-2 White Oak Laterals
3k1-2a White Oak Bayou

12 - Posten Bayou

3-57 Posten Bayou
3-57a Lower Posten Bayou

13 - Red River Main Stem

3-58 Holm Lake
3-59 Sunny Point and Half Moon Lake
3-60 East Point
3-61 Bull Lake and Sims Bayou
3-62 St. Maurice and Dunn Lakes
3-71 Wiggins Bayou

14 - Cypress Creek

3L-1 Dooley Bayou
3L-2 Waskom Laterals
3L-3 Kelly-Black Bayous
3L-4 Black Bayou
3L-5 Frazier Creek
3L-6 Caddo Lake Laterals
3L-7 Black Cypress Laterals
3L-8 Upper Frazier Creek
3L1-1 Little Cypress
3L1-2 Lilly Creek
3L1-3 Black Cypress
3L1-4 Lower Little Cypress
3L1-5 Middle Cypress
3L1-6 Upper Cypress

15 - Loggy Bayou

3m-1 Lower Toulon Bayou
3m-2 Lake Bistineau
3m1-1 Lower Bayou Dorcheat Laterals
3m1-2 Middle Bayou Dorcheat Laterals
3m1-3 Cypress Creek
3m1-4 Crooked Creek
3m1-5 Middle Bayou Dorcheat
3m1-6 Horsehead Creek
3m1-7 Big Creek
3m1-8 Upper Bayou Dorcheat
3m2-1 Lower Flat River
3m2-2 Middle Flat River
3m2-3 Cypress-Black Bayou
3m2-4 Upper West Fork of Cypress Bayou
3m2(a)-1 Red Chute
3m2(a)-2 Martin Creek
3m2(a)-3 Bayou Bodcau Laterals
3m2(a)-4 Lower Bayou Bodcau
3m2(a)-5 Middle Bayou Bodcau
3m2(a)-6 Little Bodcau Creek
3m2(a)-7 Bodcau Creek

16 - Bayou Pierre

3n-1 Jims River
3n-2 Johnson Chute
3n-3 Bayou Dupont
3n-4 Bayou Pierre Laterals
3n-5 Wallace Bayou

17 - Black and Saline Lakes

3o-1 Saline Bayou Laterals
3o-2 Lower Saline Bayou
3o-3 Upper Saline Bayou
3o1-1 Black and Clear Lake Laterals
3o1-2 Grand Bayou
3o1-3 Black Lake Bayou Laterals
3o1-4 Upper Black Lake Bayou

18 - Nantachie Creek

3-63 Nantachie Creek

19 - Cane River

3-64 Bayou Provencal
3-65 Cane River
3-66 Cocodrie and Little River
3-67 Carnahan Creek

20 - Bayou Jean de Jean

3-68 Bayou Jean de Jean

21 - Bayou Rapides

10-17 Bayou Rapides
10-18 Bertrand Bayou

22 - Bayou Rigolette

3-69 Bayou DuGrappe
3-70 Bayou Rigolette

23 - Red River Backwater

3-72 Big Creek
3-73 Vick to Saline Bayou
3-74 Muddy Bayou
3-75 Jonesville to Larto Lake
3-76 Saline Bayou to Black River
3-77 West Laterals of Old River
3-78 Old River and Little River Lakes
3-81 Bayou Natchitoches

24 - Chatlin Lake and Associated Area

10-6 Pomme de Terre
10-10 Waukasha-Courtableau
10-11 Bayou Grand Louis
10-12 Bayou Cocodrie
10-13 Bayou Rouge
10-14 Bayou Des Glaises
10-15 Bayou Boeuf
10-16 Chatlin Lake
10-19 Upper Bayou Cocodrie

Figure 1

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM

LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS

TRIBUTARY BASINS AND CONSERVATION NEEDS INVENTORY WATERSHEDS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

10 0 10 20 30 40 MILES

Rev. 1-68

OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS
EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS.

USDA-SCS-FORT WORTH, TEX. 1968

3-64

adequate aeration. This depth will vary according to crops, soils, and quality of the water.

Water in the root zone of the soil should be held between field capacity - the greatest amount which is held against the force of gravity in a well-drained soil - and the wilting point - the point at which plants wilt and fail to recover turgidity when placed in a dark, humid atmosphere. In most soils, aeration is sufficient at field capacity, but in some heavy soils almost all pores are of capillary dimensions and the soil will be water-logged at field capacity.

For proper functioning of roots, neither water stress nor oxygen stress should occur in the soil. Water supply from the capillary fringe may be important for plant growth. Drainage and flood prevention should be done at such a rate and to such a depth that it allows both for an adequate aeration and water supply of the roots during all phases of growth and development. (This is applicable only in the absence of salinity).

The beneficial effects of drainage and flood prevention are many. Soil structure is improved. Aggregation of soil particles improves conditions for aeration and water supply. The rate of infiltration and permeability of the soil will be improved by good drainage and flood prevention, provided tillage is done in a proper manner.

By lowering the water table, the water storage capacity of the soils below field capacity will be increased. The moisture content of the soil with proper drainage and flood prevention improvements generally will not exceed field capacity for long periods. This will improve conditions for traffic and more time will be available for the necessary cultivation. The hazard of drought is reduced.

A deeper root zone makes more soil available to the plant to supply nutrients. Fertilizers are more effective. Because of better aeration conditions, aerobic nitrogen fixation, nitrification, and decomposition of organic matter, with release of nitrogen and phosphates, occur at a faster rate. A soil with proper water management improvements will warm up earlier in the spring, and thus affect the time of planting and harvesting the crop. Tillage can be more timely and effective on soils with proper drainage and flood prevention improvements. Less compaction will take place.

GENERAL DESCRIPTION OF DRAINAGE AND FLOOD PREVENTION STUDIES

The New Orleans and Tulsa Districts of the U. S. Army Engineers, U. S. Department of Agriculture, and State agencies are conducting a

comprehensive review of the Red River and tributaries from the mouth of the Red River to Denison Dam. Improvements being considered in relation to drainage and flood problems on flatlands include multiple-purpose channel improvements and related structural measures; i.e., floodgates, erosion control structures, levee construction, etc.

On September 9,1965 representatives of the various Federal and State agencies who were concerned with this water resource management problem met in Shreveport, Louisiana, to consider coordinated planning in connection with the comprehensive study. These representatives have met periodically as a "Drainage Work Group" under the auspices of the Field Coordinating Committee to consider each agency's progress and plans for potential development.

The interest and activities in relation to drainage and flood problems in flatlands vary widely within the limits of the Study Area. Extensive projects have been constructed in the Arkansas and Louisiana portion of the basin complex, while very little has been constructed in the Oklahoma and Texas portion. Drainage and flood prevention activity in all states has been confined mostly to the Southern Mississippi Valley Alluvium Land Resource Area (131). The acreage on which drainage and flood prevention improvements have been installed in the other land resource areas is only a token amount.

Drainage and/or levee districts encompass nearly all of the Southern Mississippi Valley Alluvium LRA (131) in Arkansas and Louisiana. There are very few such districts in Oklahoma and Texas. Several drainage and/or levee districts of unknown status are in the Sulphur River Basin in Texas.

The U. S. Army Engineers have improved main drainage and flood prevention channels in Arkansas, Louisiana, and Texas. They have authorization and plans for additional improvements.

The Louisiana Department of Public Works began an extensive program of drainage and flood prevention improvement on flatlands in the 1940's and continued this program in the 1950's. It consisted of construction of main outlet channels. Most of these channels were spaced so they would be within easy reach of the individual farm improvements for drainage and flood prevention.

The U. S. Department of Agriculture drainage and flood prevention studies on flatlands by the Soil Conservation Service, Forest Service, and Economic Research Service provide significant information on interrelated land and water resource development, with regard to location, nature, and extent of existing and potential agricultural water management developments. Potential Public Law 566 projects for drainage and flood prevention improvements were identified. Projects beyond the scope of P. L. 566 were also recognized.

Methodology

The Conservation Needs Inventory data prepared in 1958 and updated to 1962 were used as the source for tabulation of the flatland soils with a drainage and flood problem. This information was developed and summarized for each county (or parish), or tributary basin subdivision of each county (or parish).

A two-man SCS survey team consisting of an engineer and an economist contacted USDA personnel in the four-state complex of the Red River Basin for assistance in allocating soils with a drainage and flood problem into the Conservation Needs Inventory watersheds and in making necessary adjustments in the tabulated data. These field personnel provided assistance in identifying drainage and flood prevention improvements for 1962. Drainage and flood problem areas were identified as to their potential for future water resource management development. Also, these areas were examined by this survey team to ascertain their feasibility for development.

The Economic Research Service developed crop and pasture yields for land resource areas with inadequate drainage and flood prevention improvements. Proper drainage and flood prevention improvements were considered as these problems related to increased yields and returns. Present land use and the potential land use with adequate water management were analyzed by land resource areas and major crop distribution. These elements of water resource management were used to evaluate the economic feasibility.

Explanation of Terms

The definitions and explanations of terms used in tabular data in this report are given as follows:

Flood Prevention on flatlands is defined as works of improvement for the conveyance, control, and disposal of surface water caused by abnormally high, direct precipitation, runoff from higher elevations, and from stream overflow.

Drainage on flatlands is defined as works of improvement installed for the purpose of removing the excess water from the plant root zone of the soil or from the soil surface in areas where normal precipitation, seepage, or excess irrigation water keeps the soil too wet for the most economical agricultural production.

The Drainage and Flood Problem Area is a broad, general, more or less contiguous area having drainage and flood problems. It may include not only lands in need of drainage and flood prevention for improved agricultural production, but also interspersed areas

not requiring drainage and flood prevention or lands not feasible for drainage and flood prevention.

Soils With No Drainage and Flood Problems are generally those soils, within the overall limits of the problem areas, that are permeable or freely permeable, have slopes exceeding one percent, and do not have a high water table.

Soils With Drainage and Flood Problems are those soils included in CNI laboratory print-out sheets in land capability subclasses "w" and "s" which indicate that drainage and flood problems exist. The "w" indicates that excess water is the dominant problem. The "s" indicates soil limitations within the rooting zone. This classification is from a physical properties basis, only, and disregards whether the use made of the soil would or would not require drainage and flood prevention. This acreage equals the acreage included in the "drainage and flood problem area" minus the "soils with no drainage and flood problems."

Soils With Adequate Drainage and Flood Prevention Improvement are those soils with a drainage and flood problem on which adequate channel improvement has been installed.

Soils With Inadequate Drainage and Flood Prevention Improvement are those soils with a drainage and flood problem on which adequate channels have not been installed. This acreage equals the acreage included in the "soils with a drainage and flood problem" minus the "soils with adequate drainage and flood prevention improvement."

Soils With Adequate Outlets include the acreage of "soils with inadequate drainage and flood prevention improvement" where main outlet channels are available and can be reached by on-farm or group channel improvements. In most cases, these will be gravity flow channels.

Soils With Inadequate Outlets include the acreage of "soils with inadequate drainage and flood prevention improvement" where main outlet channel development is beyond the scope of SCS programs. The acreage of "soils with adequate outlets" plus "soils with inadequate outlets" equals the acreage of "soils with inadequate drainage and flood prevention improvement."

On-Farm Drainage and Flood Prevention Improvement consists of systems of farm laterals and surface field ditches, and appurtenant structures installed and maintained to adequately correct the on-farm soils with a drainage and flood problem. On-farm system components can be adequately designed and installed on individual farms. Their functioning is not dependent on bordering

on-farm systems, although they may require joint use of group facilities to provide access to main outlet channels. This acreage equals the acreage of "soils with inadequate drainage and flood prevention improvement."

Group Drainage and Flood Prevention Improvement consists of lateral ditches and appurtenant structures required to move water from on-farm systems to main outlet channels. Installation requires integrated planning of two or more farm owners or operators. This acreage is some percentage of the acreage of the "soils with inadequate drainage and flood prevention improvement."

Project-Type Group Drainage and Flood Prevention Improvement is that acreage of "soils with inadequate drainage and flood prevention improvement" normally large enough to require legally organized groups to accomplish drainage and flood prevention.

Nonproject-Type Group Drainage and Flood Prevention Improvement is that acreage of "soils with inadequate drainage and flood prevention improvement" on which proper channel improvement can be obtained by small, informal groups.

Main Outlet Channels consist of gravity flow channels serving large areas of on-farm or group drainage and flood prevention improvement systems. The computed stage of a stream during the storm when the drainage system is discharging at the design rate determines the adequacy of an outlet. Drainage criteria used for crops is the capacity to remove excess rainfall from a 24-hour storm that can be expected on a frequency of once in 2 to 3 years.

Land Use refers to the use being made of the agricultural land. There are three land uses considered in this report: cropland, pasture, and woodland.

A Tributary Basin is a major drainage area, unlimited in size, of the Study Area.

A Conservation Needs Inventory Watershed is defined as a subdivision of a tributary basin amounting to 250,000 acres or less.

A Major Land Resource Area is an area of broadly uniform conditions of soils, topography, climate, and vegetation. Land resource areas and identifying symbols included in

this report consist of Cherokee Prairies (112), Cross Timbers (84 and 84a), Grand Prairie (85), Ouachita Mountains (119), Southern Coastal Plain (133), Southern Mississippi Valley Alluvium (131), Southern Mississippi Valley Silty Uplands (134), and Texas Blackland Prairie (86). The Southern Mississippi Valley Alluvium LRA includes all of the Red River alluvial area. Land resource areas in the Red River Basin are shown in figure 2. A more comprehensive description of all land resource areas is contained in the Upstream Watershed Protection, Use, Management, and Development appendix.

Source of Data

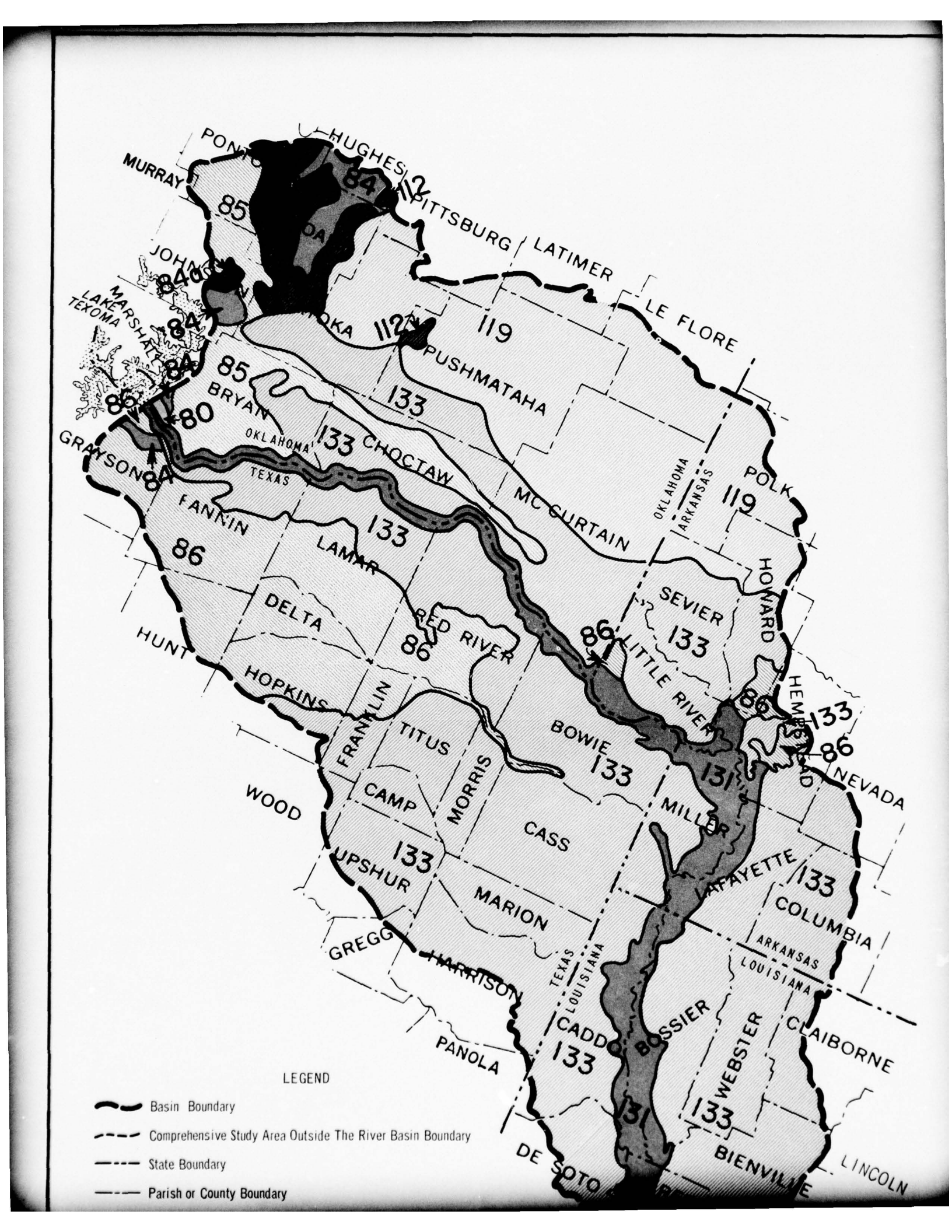
The water management problem resulting from "excess water or wetness of soil" and the problem resulting from a soils limitation can be studied by appraising the acreages coded with the land capability subclass identifications "w" and "s." 1/ These limitation factors are groupings of individual soil mapping units, which are adapted to the same kind of cultivated crops or pasture plants, and that require similar management. Projects that are installed may change the limitations in land use. Examples include establishing major drainage facilities, building levees or flood-retarding facilities, and providing water for irrigation.

The *Drainage Reconnaissance Survey*, 1948, and the 1965 updated Drainage Survey Report, Texas, made by the U. S. Department of Agriculture, Soil Conservation Service, were used as reference material in the Drainage appendix. Since similar information as that developed in the Drainage Survey Report, Texas, was not available in other states, the 1958 Conservation Needs Inventory data, updated to 1962, were used as a common base for all states in the Study Area. USDA personnel furnished information regarding 1962 land use and crop distribution, average yields, and anticipated changes which could be expected to result from project installation. Additional information concerning soils with a drainage and flood problem in each watershed was obtained from local SCA personnel as follows:

1. Acreage with adequate drainage and flood prevention improvement

---

1/ Subclass "w," excess water - Soils in which excess water is the dominate hazard or limitation in their use. Poor soil drainage, wetness, high water table, and overflow are the criteria for determining which soils belong in this subclass. Subclass "s," soil limitations within the rooting zone - Soils that have such limitations as shallowness of rooting zones, stones, low moisture-holding capacity, low fertility difficult to correct, and salinity, or sodium.


HUGHES
PONTOTOC
MURRAY
PITTSBURG
LATIMER
LE FLORE
JOHNSTON
MARSHALL
LAKE TEXOMA
PUSHMATAHA
BRYAN
OKLAHOMA
TEXAS
CHOCTAW
MC CURTAIN
OKLAHOMA
ARKANSAS
POLK
GRAYSON
FANNIN
LAMAR
DELTA
RED RIVER
SEVIER
HOWARD
HUNT
HOPKINS
FRANKLIN
TITUS
BOWIE
LITTLE RIVER
HEMPSTEAD
NEVADA
WOOD
CAMP
MORRIS
CASS
MILLER
UPSHUR
MARION
LAFAYETTE
COLUMBIA
GREGG
HARRISON
TEXAS
LOUISIANA
ARKANSAS
LOUISIANA
CADDO
BOSSIER
WEBSTER
CLAIBORNE
PANOLA
DE SOTO
BIENVILLE
LINCOLN
LEGEND
Basin Boundary
Comprehensive Study Area Outside The River Basin Boundary
State Boundary
Parish or County Boundary

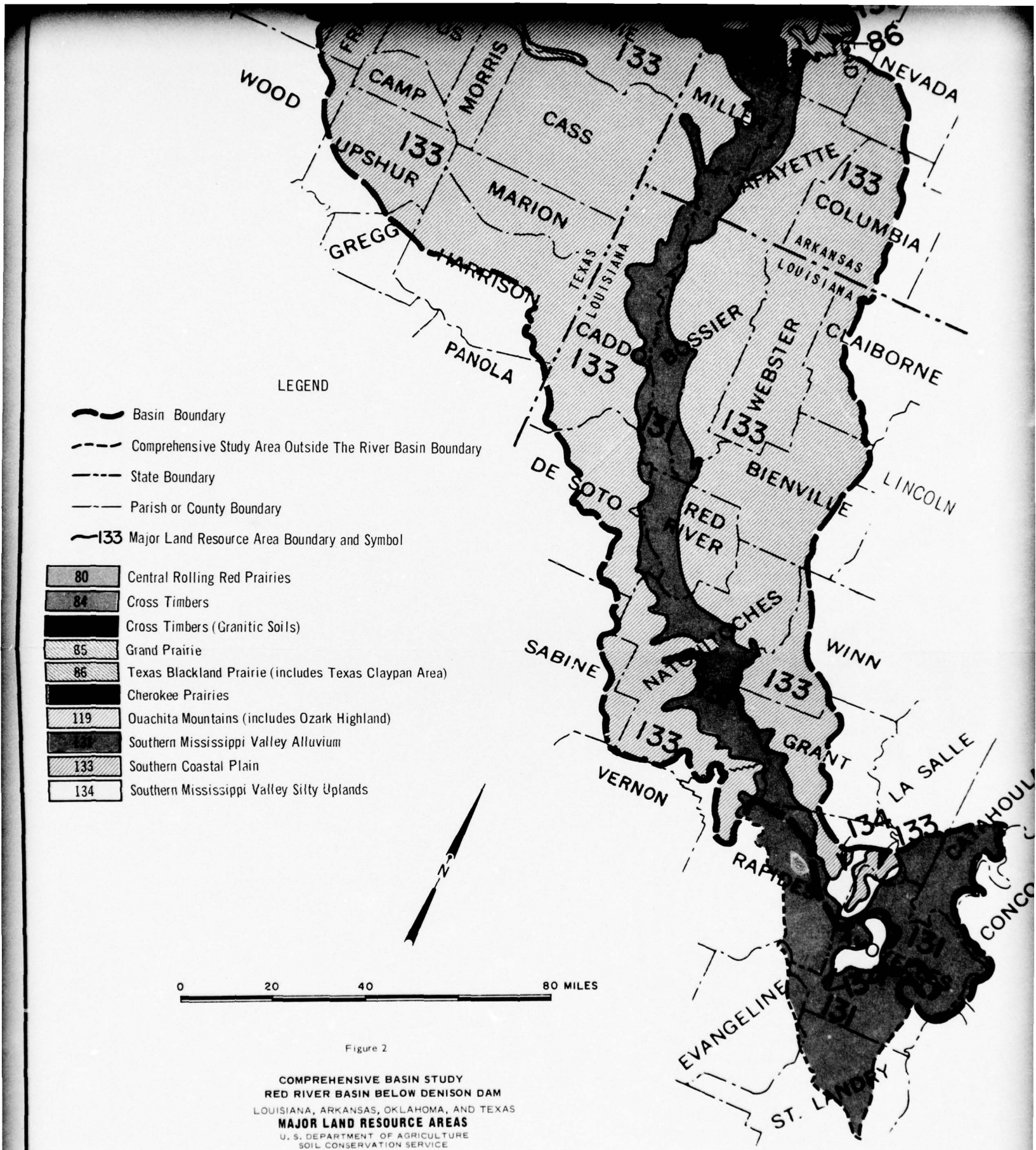


Figure 2

COMPREHENSIVE BASIN STUDY
RED RIVER BASIN BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
MAJOR LAND RESOURCE AREAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

USDA-SCS-FORT WORTH, TEX. 1968

2. Acreage with inadequate drainage and flood prevention improvement

3. Acreage with inadequate drainage and flood prevention improvement having adequate outlets

4. Acreage with inadequate drainage and flood prevention improvement having inadequate outlets

5. Acreage of potential on-farm drainage and flood prevention improvement

6. Acreage of potential group drainage and flood prevention improvement

7. Acreage of potential group drainage and flood prevention improvement that would need project-type improvement

8. Acreage of potential group drainage and flood prevention improvement that would need nonproject-type improvement

The local community interest and public opinions were considered as they related to potential development of small watershed projects under Public Law 566.

The acreage of soils with a drainage and flood problem as presented in this appendix does not equal the acreage in subclass "w" and "s" presented in the Upstream Watershed Protection, Use, Management, and Development appendix. The reasons that these acreages are not equal are:

1. Tabulations of soils with a drainage and flood problem did not include all soils in subclasses "w" and "s." The respective state technical guides, giving soils on which drainage and flood prevention improvement is recommended, were used in selecting those soils to be included. These technical guides do not recommend drainage and flood prevention improvement on all subclass "w" and "s" soils.

2. Tabulations of soils with a drainage and flood problem as developed from CNI data were used as a guide in field studies. Adjustments in the acreages were made when necessary after consultation with the local Soil Conservation Service personnel.

Drainage and Flood Problem Scope

This appendix presents results of studies and investigations to determine the feasibility and justification of improvements for

drainage and flood prevention on the flatland areas on the main stem and principal tributaries of Red River below Denison Dam, exclusive of the Ouachita-Black River. In order to present a broad view of this study problem, soils that have a drainage and flood problem, and their relation to the agricultural situation were considered insofar as benefits to these purposes were incidental to the basic purpose of land and water resource improvement and development.

Soils

The dominate hazards on soils with a drainage and flood problem include poor soil drainage, wetness, high water table, or overflow. Also included in these soils are soils that have soil limitations within the rooting zone. This hazard could be reduced by drainage.

Agricultural drainage may involve alleviation of both surface and subsurface problems. Surface problems are those occurring on flat or nearly flat areas of land. Subsurface problems arise from a variety of sources. Normally, they may be considered as high water table problems resulting from rainfall.

Although surface drainage is the predominant drainage problem in the Study Area, there are areas where subsurface drainage is a problem. The CNI data does not list the soils that would require subsurface drainage. Generally, these problem areas are too small to be mapped separately. The total acreage in the Study Area needing subsurface drainage is relatively small in relation to the acreage needing surface drainage. Areas needing subsurface drainage could be drained by the individual farmer or through small, informal groups. Outlet channels serving these areas would possibly need to be deeper than normal to insure proper operation of subsurface drains.

Generally, the entire acreage of soils with a durface drainage problem is considered to have a flood problem because the entire Study Area is subject to periods of abnormally high rainfall. (See definitions of drainage and flood prevention as given in a previous section).

Agriculture

In areas where drainage and flooding are the major physical agricultural problems, the welfare and prosperity of the people are almost directly proportional to the degree of adequacy with which drainage and flood prevention works of improvement are planned, constructed, and maintained. Although individual efforts have been made toward disposal of excess water for many years, few of these are considered adequate unless they supplemented organized efforts at providing adequate outlet channels. Of approximately 4,822,400 acres of soils with a drainage and flood problem at the present time, about 424,200 acres have adequate drainage and flood prevention improvements. On some acreage in the Cherokee Prairies (112) and Southern

Coastal Plain (133) Land Resource Areas of Oklahoma, which is considered to have adequate drainage and flood prevention improvements, this has been accomplished incidentally to installation of P. L. 566 flood prevention projects.

The main physiological effects of inadequate drainage on crop plants are the lack of aeration. The economic effects of the drainage and flood problem are lower returns to farmers brought about by decreased yields for various crops and less intensive land use due to hazards accompanying the problem.

Studies for the U. S. Army Engineers' Interim Report

A study was made in 1964 at the request of the U. S. Army Corps of Engineers, New Orleans District, to determine the effects that a proposed navigation project on Red River would have on drainage and flood prevention on flatlands. Proposed navigation pool elevations were checked against elevations of natural drains emptying into the Red River. Investigations indicate that the navigation project would not interfere with agricultural surface drainage and flood prevention on flatlands in Louisiana.

The CE "Interim Report on Navigation and Bank Stabilization," March 1966, does not consider navigation on Red River above Shreveport. Preliminary investigations in the other states indicate a need for coordination of surface drainage and flood prevention needs on flatlands if navigation of the Red River above Shreveport is considered in the comprehensive report. Changes in river channel alignment and permanent changes in water elevations could have definite effects on drainage and flood problems.

Effects of proposed navigation pools on ground water table levels were studied. Raised water tables would adversely affect approximately 52,480 acres in Louisiana. Provisions for subsurface drainage would need to be made in these areas. A large portion of this acreage also will need surface drainage and flood prevention.

DRAINAGE AND FLOOD PROBLEM ON FLATLANDS

An inventory was made of the soils in the Study Area "mapped" with a wetness condition or soil limitations within the rooting zone that, according to SCS state technical guides, are recommended for drainage and flood prevention improvement. There are 4,822,400 acres of soils with a drainage and flood problem located within a total drainage and flood problem area of 5,407,400 acres. The 585,000-acre difference represents interspersed areas of permeable soils having no problem.

Of the 4,822,400 acres of soils with a drainage and flood problem, 424,200 acres have had adequate improvements installed, leaving 4,398,200 acres with a problem.

The 4,398,200 acres remaining with inadequate drainage and flood prevention improvements represent 423,200 acres of cropland, 592,200 acres of pasture, and 3,382,800 acres of woodland.

DESCRIPTION OF PROBLEM

Causes

Many factors are involved when considering the causes of drainage and flood problems on flatlands. The fact that the lands are flat or nearly flat causes a problem in itself. Physical properties of soils are a prime cause of drainage and flood problems. Slower permeable soils in connection with flat slopes magnify the problem.

Causes of surface drainage and flood problems are the main concern in this appendix. These are considered together because of the interrelationship of the two problems. The Study Area is subjected to periods of abnormally high, direct precipitation and stream flow making the problems more or less inseparable. (see definitions of drainage and flood prevention in previous section).

Uneven land surface with pockets or ridges prevent or retard natural runoff. Low capacity disposal channels within the problem area remove water so slowly that the high water level in the channels causes ponding on the land for damaging periods. High stages in lakes and ponds create poor outlet conditions in some areas. Failure to control soil erosion on the watershed causes the filling of ditches by sediment. Lack of farm drainage and flood prevention collection systems is a factor. Inadequate appraisals are often made of the suitability of land for agricultural use when drainage and flood prevention improvements are undertaken. Many times consideration is not given to constructing drainage and flood prevention improvements on a watershed basis.

Subsurface drainage problems arise from many causes. Flatland tends to be poorly drained, particularly where the subsoil permeability is slow. There are many wet areas where there is no evident connection between an area of seepage, or a high water table, and the topography of the site. High water tables may occur in slowly or rapidly permeable soils, where the climate is either humid or arid, and where the land is either sloping or flat.

Lack of proper maintenance of drainage and flood prevention improvements on flatlands is a cause of problems arising in connection with both surface and subsurface drainage, and flood prevention.

Extent

Drainage and flood problem areas are found in all land resource areas in the basin complex. The Southern Mississippi Valley Alluvium (131) and Southern Coastal Plain (133) Land Resource Areas contain 85 percent of the drainage and flood problem area with the Southern Mississippi Valley Alluvium Land Resource Area (131) containing the greater amount.

About 90 percent of the Southern Mississippi Valley Alluvium LRA (131) is considered to be in the drainage and flood problem area. Interspersed within this problem area are relatively small areas with no drainage and flood problem. These areas consist of soils occupying the natural levee positions along rivers and old stream courses, such as bayous and old river lakes. The areas containing soils with a drainage and flood problem occupy an intermediate position between the natural levees and the low bottomland and swamp areas, and those soils which occupy positions of lowest elevation.

Drainage and flood problem areas are found in all land resource areas either singly or in combination. One consists of soils located adjacent to the natural streams. The other consists of soils located in "hilltop flats." The latter type problem area may occur in large, contiguous areas.

Effects

The main physiological effects of inadequate drainage and flood prevention on crop plans is the lack of aeration in the soil. Soil pore space is occupied by water, and is not available for air. This condition inhibits certain bacterial action in the soil, influences soil temperature, and prevents a proper balance in the soil of air, water, and nutrients necessary to sustain normal plant development. Soil structure is adversely affected and plant diseases, pests, and parasites are encouraged.

The normal development of crops inhibited by inadequate drainage and flood prevention results in reduced yields. Although crop yields vary greatly, increases ranging between 25 percent and 60 percent can usually be expected with adequate drainage and flood prevention on flatlands.

Other operations relating to crop production are adversely affected by inadequate drainage and flood prevention. Proper land preparation is often prevented. Some areas will be too wet for tillage, while other parts of a field are in optimum condition for the operation. Planting and cultivation is delayed and the most efficient mechanical operations cannot be carried out. Harvesting

operations are delayed or carried out with lower efficiency. Thus, production is affected by factors other than crop yields when conditions of inadequate drainage and flood prevention on flatlands exists. The quality of the product harvested often is lowered in grade when these conditions exist.

Inadequate drainage and flood prevention often affect residents in transportation to markets, schools, and other places of destination when roads are inundated. Indirect damages resulting from the many inconveniences and extra expenses involved are attributable to the problems of inadequate drainage and flood prevention.

INVENTORY OF PROBLEM

A drainage and flood problem inventory by land use and tributary basin is presented in table 1. The 1958 CNI data, updated to 1962, were used in developing the data for this table and all other acreage tables in the appendix. Table 1 is divided into three parts: (1) Drainage and flood problem area; (2) Soils with no drainage and flood problem; and (3) Soils with a drainage and flood problem.

Land use, as presented in table 1, does not have an effect on whether or not the soil is classed as having a drainage and flood problem. Soil mapping units were used to determine the acreages shown. As explained in the "Source of Data" section, those soils coded with the land capability subclass identifications "w" and "s" indicate soils with an excess water problem and soils with limitations within the rooting zone. A tabulation of the soils "mapped" with land capability subclass symbols that are recommended for drainage and flood prevention improvement, disregarding land use, is contained in the soils with a drainage and flood problem portion of table 1.

As explained in the "Extent" section of the description of the problem, the soils with no drainage and flood problem are interspersed areas of permeable soils located within the general drainage and flood problem area. The acreage of soils with a drainage and flood problem plus the acreage of soils with no drainage and flood problem equal the drainage and flood problem area.

Of the 18,661,000 acres of land area in the Study Area, about 5,407,400 acres are included in the drainage and flood problem area. Of this acreage, 585,000 acres have no drainage and flood problem and 4,822,400 acres have a drainage and flood problem.

A subdivision of the tributary basin acreages, presented in table 1, by States and land resource areas is presented in exhibit 1.

Table 1 data are summarized by land use, State, and land resource area in table 1A. The 5,407,400-acre drainage and flood problem area

TABLE 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE AND TRIBUTARY BASIN

Red River Basin Study Area, 1962

Tributary Basin	Drainage & Flood Problem Area				Soils with no Drainage and Flood Problem				Soils with a Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(Acres - Thousands)											
Barkman Creek	6.7	6.8	15.5	29.0	1.8	4.3	1.3	7.4	4.9	2.5	14.2	21.6
Bayou Jean de Jean	0.2	0.6	16.7	17.5	0.1	0.1	0.1	0.3	0.2	0.5	16.6	17.3
Bayou Pierre	66.1	89.8	166.6	322.5	24.3	12.8	1.3	38.4	41.8	77.1	165.3	284.2
Bayou Rapides	11.4	18.1	8.8	38.3	3.2	2.0	0.1	5.3	8.1	16.1	8.8	33.0
Bayou Rigolette	19.3	17.8	49.1	86.2	11.5	2.0	1.5	15.0	7.8	15.8	47.6	71.2
Black and Saline Lakes	3.8	16.5	172.7	193.0	2.0	0.6	0.1	2.7	1.8	16.0	172.6	190.4
Blue River	2.6	5.0	12.1	19.7	1.3	1.6	1.3	4.2	1.3	3.4	10.7	15.4
Boggy Creek	18.1	22.7	107.5	148.3	1.9	-	1.9	3.8	16.3	22.7	105.7	144.7
Bois d'Arc Creek	8.6	7.7	36.7	53.0	5.6	2.2	3.4	11.2	3.1	5.5	33.2	41.8
Cane River	19.7	43.1	112.5	175.3	12.4	2.4	1.9	16.7	7.3	40.7	110.6	158.6
Chatlin Lake and Associated Area	122.7	106.4	259.7	488.8	42.0	19.3	28.6	89.9	80.6	87.1	231.2	398.9
Cypress Creek	100.9	102.8	339.7	543.4	31.0	9.8	2.6	43.4	69.9	93.0	337.1	500.0
Kiamichi River	5.0	24.9	75.1	105.0	-	-	-	-	5.0	24.9	75.1	105.0
Little River	13.3	40.0	298.4	351.7	Z	0.1	Z	0.1	13.3	39.9	298.4	351.6
Loggy Bayou	45.4	42.5	516.9	604.8	4.0	1.4	0.5	5.9	41.4	41.1	516.4	598.9
Maniece Bayou	16.6	13.4	25.4	55.4	13.4	3.6	4.7	21.7	3.2	9.7	20.7	33.6
McKinney Bayou	60.3	28.6	78.3	167.2	42.4	17.7	4.4	64.5	17.8	10.8	73.9	102.5
Intervening Areas-Arkansas and Oklahoma	94.9	68.5	93.9	257.3	66.0	16.7	8.2	90.9	28.9	51.7	85.7	166.3
Intervening Areas-Texas	123.3	51.6	232.4	407.3	13.9	12.0	5.3	31.2	109.4	39.6	227.1	376.1
Nantachie Creek	-	0.3	10.1	10.4	-	-	-	-	-	0.3	10.1	10.4
Posten Bayou	34.0	17.4	16.0	67.4	13.9	10.8	-	24.7	20.1	6.6	15.9	42.6
Red River Backwater Area	35.4	29.7	363.3	428.4	17.6	6.1	-	23.7	17.8	23.6	363.3	404.7
Red River Main Stem	24.1	70.3	97.2	191.6	15.0	43.9	25.1	84.0	9.1	26.5	72.1	107.7
Sulphur River	136.7	131.0	378.2	645.9	-	-	-	-	136.7	131.0	378.2	645.9
Grand Total	969.1	955.5	3,482.8	5,407.4	323.3	169.4	92.3	585.0	645.8	786.1	3,390.5	4,822.4

Z - Too small to be reported

TABLE 1A - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

State and Land Resource Area	Drainage & Flood Problem Area				Soils With No Drainage And Flood Problem				Soils With A Drainage And Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(Acres - Thousands)											
Arkansas												
86	12.0	7.8	4.8	24.6	-	-	-	-	12.0	7.8	4.8	24.6
119	-	0.9	23.6	24.5	-	-	-	-	-	0.9	23.6	24.5
131	142.6	65.0	160.6	368.2	104.8	36.2	12.0	153.0	37.8	28.8	148.6	215.2
133	13.1	46.2	568.5	627.8	-	-	-	-	13.1	46.2	568.5	627.8
Total	167.7	119.9	757.5	1,045.1	104.8	36.2	12.0	153.0	62.9	83.7	745.5	892.1
Louisiana												
131	419.0	382.5	846.6	1,648.1	163.7	101.8	61.7	327.2	255.3	280.7	784.9	1,320.9
133	2.9	66.3	669.9	739.1	-	-	-	-	2.9	66.3	669.9	739.1
134	11.9	17.4	20.1	49.4	-	-	-	-	11.9	17.4	20.1	49.4
Total	433.8	466.2	1,536.6	2,436.6	163.7	101.8	61.7	327.2	270.1	364.4	1,474.9	2,109.4
Oklahoma												
84 and 84a	0.3	1.5	0.7	2.5	-	-	-	-	0.3	1.5	0.7	2.5
85	0.6	4.2	48.5	53.3	-	-	-	-	0.6	4.2	48.5	53.3
86	0.5	0.3	0.1	0.9	-	-	-	-	0.5	0.3	0.1	0.9
112	3.8	8.8	50.3	62.9	-	-	-	-	3.8	8.8	50.3	62.9
119	4.0	20.7	78.7	103.4	-	-	-	-	4.0	20.7	78.7	103.4
131	65.8	45.0	45.6	156.4	38.1	12.6	11.4	62.1	27.7	32.4	34.2	94.3
133	1.7	33.0	92.6	127.3	-	-	-	-	1.7	33.0	92.6	127.3
Total	76.7	113.5	316.5	506.7	38.1	12.6	11.4	62.1	38.6	100.9	305.1	444.6
Texas												
86	168.7	97.0	181.9	447.6	-	-	-	-	168.7	97.0	181.9	447.6
131	64.6	37.4	61.0	163.0	16.7	18.8	7.2	42.7	47.9	18.6	53.8	120.3
133	57.6	121.5	629.3	808.4	-	-	-	-	57.6	121.5	629.3	808.4
Total	290.9	255.9	872.2	1,419.0	16.7	18.8	7.2	42.7	274.2	237.1	865.0	1,376.3
Grand Total	969.1	955.5	3,482.8	5,407.4	323.3	169.4	92.3	585.0	645.8	786.1	3,390.5	4,822.4

is divided between the States as follows: Arkansas - 1,045,100 acres; Louisiana - 2,436,600 acres; Oklahoma - 506,700 acres, and Texas - 1,419,000 acres. The 585,000 acres of soils with no drainage and flood problem are divided as follows: Arkansas - 153,000 acrea; Louisiana - 327,200 acres; Oklahoma - 62,100 acres, and Texas - 42,700 acres. The 4,822,400 acres of soils with a drainage and flood problem are divided as follows: Arkansas - 892,100 acres; Louisiana - 2,109,400 acres; Oklahoma - 444,600 acres; and Texas - 1,376,300 acres.

Table 1 data are summarized by land use and land resource area in table 1B.

ANALYSIS OF PROBLEM

An analysis of the drainage and flood problem is presented by land use and tributary basin in table 2. The soils with a drainage and flood problem are divided into two categories: soils with adequate drainage and flood prevention improvement and soils with inadequate drainage and flood prevention improvement. Soil Conservation Service criteria were used in determining the acreage of soils with adequate drainage and flood prevention improvement. On-farm drainage and flood prevention needs have been satisfied on these acreages.

Land use was not a factor in determining the acreage of soils with a drainage and flood problem, as Shown in tables 1 and 2. Therefore, it does not affect the acreage presented in table 2 as soils with inadequate drainage and flood prevention improvement. The acreage of soils with a drainage and flood problem minus the acreage of soils with adequate drainage and flood prevention improvement equals the remaining soils with inadequate drainage and flood prevention improvement.

Adequate drainage and flood prevention improvements have been installed on 424,200 acres in the Study Area. There are 4,398,200 acres remaining with inadequate drainage and flood prevention improvement.

A subdivision of the tributary basin acreages, presented in table 2, into States and land resource areas is presented in exhibit 2.

Table 2 data are summarized by land use, State,and land resource area in table 2A. The 424,200 acres of soils with adequate drainage and flood prevention improvement are divided as follows: Arkansas - 46,200 acres; Louisiana - 309,300 acres; Oklahoma - 39,900 acres; and Texas - 28,800 acres. The 4,398,300 acres of soils with inadequate drainage and flood prevention improvement is divided as follows: Arkansas - 845,900 acres; Louisiana - 1,800,100 acres; Oklahoma - 404,700 acres; and Texas - 1,347,500 acres.

TABLE 1B - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

Land Resource Area	Drainage & Flood Problem Area				Soils With No Drainage And Flood Problem				Soils With a Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(Acres - Thousands)											
84 and 84a	0.3	1.5	0.7	2.5	-	-	-	-	0.3	1.5	0.7	2.5
85	0.6	4.2	48.5	53.3	-	-	-	-	0.6	4.2	48.5	53.3
86	181.2	105.1	186.8	473.1	-	-	-	-	181.2	105.1	186.8	473.1
112	3.8	8.8	50.3	62.9	-	-	-	-	3.8	8.8	50.3	62.9
119	4.0	21.6	102.3	127.9	-	-	-	-	4.0	21.6	102.3	127.9
131	692.0	529.9	1,113.8	2,335.7	323.3	169.4	92.3	585.0	368.7	360.5	1,021.5	1,750.7
133	75.3	267.0	1,960.3	2,302.6	-	-	-	-	75.3	267.0	1,960.3	2.302.6
134	11.9	17.4	20.1	49.4	-	-	-	-	11.9	17.4	20.1	49.4
Grand Total	969.1	955.5	3,482.8	5,407.4	323.3	169.4	92.3	585.0	645.8	786.1	3,390.5	4,822.4

TABLE 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE AND TRIBUTARY BASIN

Red River Basin Study Area, 1962

Tributary Basin	Soils With A Drainage And Flood Problem				Soils With Adequate Drainage And Flood Prevention Improvement				Soils With Inadequate Drainage And Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(Acres - Thousands)											
Barkman Creek	4.9	2.5	14.2	21.6	1.3	0.7	0	2.0	3.6	1.8	14.2	19.6
Bayou Jean de Jean	0.2	0.5	16.6	17.3	0	0	0	0	0.2	0.5	16.6	17.3
Bayou Pierre	41.8	77.1	165.3	284.2	24.1	24.2	0	48.3	17.7	52.9	165.3	235.9
Bayou Rapides	8.1	16.1	8.8	33.0	3.7	5.6	0	9.3	4.4	10.5	8.8	23.7
Bayou Rigolette	7.8	15.8	47.6	71.2	5.1	9.6	0	14.7	2.7	6.2	47.6	56.5
Black and Saline Lakes	1.8	16.0	172.6	190.4	0.6	1.8	0	2.4	1.2	14.2	172.6	188.0
Blue River	1.3	3.4	10.7	15.4	0.3	1.2	0	1.5	1.0	2.2	10.7	13.9
Boggy Creek	16.3	22.7	105.7	144.7	6.9	18.7	3.4	29.0	9.4	4.0	102.3	115.7
Bois d'Arc Creek	3.1	5.5	33.2	41.8	2.3	1.7	1.5	5.5	0.8	3.8	31.7	36.3
Cane River	7.3	40.7	110.6	158.6	6.6	30.5	0	37.1	0.7	10.2	110.6	121.5
Chatlin Lake and Associated Area	80.6	87.1	231.2	398.9	64.7	52.1	0	116.8	15.9	35.0	231.2	282.1
Cypress Creek	69.9	93.0	337.1	500.0	33.6	6.0	0	39.6	36.3	87.0	337.1	460.4
Kiamichi River	5.0	24.9	75.1	105.0	2.2	0.3	0	2.5	2.8	24.6	75.1	102.5
Little River	13.3	39.9	298.4	351.6	5.7	4.0	0	9.7	7.6	35.9	298.4	341.9
Loggy Bayou	41.4	41.1	516.4	598.9	10.8	5.5	0	16.3	30.6	35.6	516.4	582.6
Maniece Bayou	3.2	9.7	20.7	33.6	0.5	1.5	0	2.0	2.7	8.2	20.7	31.6
McKinney Bayou	17.8	10.8	73.9	102.5	8.0	4.8	2.5	15.3	9.8	6.0	71.4	87.2
Intervening Areas - Ark. and Okla.	28.9	51.7	85.7	166.3	7.2	8.1	0.3	15.6	21.7	43.6	85.4	150.7
Intervening Areas - Texas	109.4	39.6	227.1	376.1	14.1	4.6	0	18.7	95.3	35.0	227.1	357.4
Nantachie Creek	0	0.3	10.1	10.4	0	0	0	0	0	0.3	10.1	10.4
Posten Bayou	20.1	6.6	15.9	42.6	9.5	2.4	0	11.9	10.6	4.2	15.9	30.7
Red River Backwater Area	17.8	23.6	363.3	404.7	6.9	4.0	0	10.9	10.9	19.6	363.3	393.8
Red River Main Stem	9.1	26.5	72.1	107.7	3.3	6.0	0	9.3	5.8	20.5	72.1	98.4
Sulphur River	136.7	131.0	378.2	645.9	5.2	0.6	0	5.8	131.5	130.4	378.2	640.1
Grand Total	645.8	786.1	3,390.5	4,822.4	222.6	193.9	7.7	424.2	423.2	592.2	3,382.8	4,398.2

TABLE 2A - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

State and Land Resource Area	Soils With A Drainage And Flood Problem				Soils With Adequate Drainage And Flood Prevention Improvement				Soils With Inadequate Drainage And Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(acres - thousands)											
Arkansas												
86	12.0	7.8	4.8	24.6	6.5	2.6	0	9.1	5.5	5.2	4.8	15.5
119	0	0.9	23.6	24.5	0	0.1	0	0.1	0	0.8	23.6	24.4
131	37.8	28.8	148.6	215.2	15.6	8.7	4.0	28.3	22.2	20.1	144.6	186.9
133	13.1	46.2	568.5	627.8	2.9	5.6	0.2	8.7	10.2	40.6	568.3	619.1
Total	62.9	83.7	745.5	892.1	25.0	17.0	4.2	46.2	37.9	66.7	741.3	845.9
Louisiana												
131	255.3	280.7	784.9	1,320.9	158.6	141.4	0	300.0	96.7	139.3	784.9	1,020.9
133	2.9	66.3	669.9	739.1	0.1	Z	0	0.1	2.8	66.3	669.9	739.0
134	11.9	17.4	20.1	49.4	5.4	3.8	0	9.2	6.5	13.6	20.1	40.2
Total	270.1	364.4	1,474.9	2,109.4	164.1	145.2	0	309.3	106.0	219.2	1,474.9	1,800.1
Oklahoma												
84 and 84a	0.3	1.5	0.7	2.5	0	0	0	0	0.3	1.5	0.7	2.5
85	0.6	4.2	48.5	53.3	0.4	1.7	0.3	2.4	0.2	2.5	48.2	50.9
86	0.5	0.3	0.1	0.9	0	0	0	0	0.5	0.3	0.1	0.9
112	3.8	8.8	50.3	62.9	3.8	8.8	3.2	15.8	0	0	47.1	47.1
119	4.0	20.7	78.7	103.4	1.4	1.2	0	2.6	2.6	19.5	78.7	100.8
131	27.7	32.4	34.2	94.3	4.3	2.0	0	6.3	23.4	30.4	34.2	88.0
133	1.7	33.0	92.6	127.3	1.5	11.3	0	12.8	0.2	21.7	92.6	114.5
Total	38.6	100.9	305.1	444.6	11.4	25.0	3.5	39.9	27.2	75.9	301.6	404.7
Texas												
86	168.7	97.0	181.9	447.6	6.8	1.0	0	7.8	161.9	96.0	181.9	439.8
131	47.9	18.6	53.8	120.3	15.0	5.6	0	20.6	32.9	13.0	53.8	99.7
133	57.6	121.5	629.3	808.4	0.3	0.1	0	0.4	57.3	121.4	629.3	808.0
Total	274.2	237.1	865.0	1,376.3	22.1	6.7	0	28.8	252.1	230.4	865.0	1,347.5
Grand Total	645.8	786.1	3,390.5	4.822.4	222.6	193.9	7.7	424.2	423.2	592.2	3,382.8	4,398.2

Z = Too small to be reported.

Table 2 data are summarized by land use and land resource area in table 2B.

Three land resource area groupings account for 95 percent of the total area with inadequate drainage and flood prevention improvement. Land resource area 86 (Texas Blackland Prairie), land resource area grouping 131 and 134 (Southern mississippi Valley Alluvium, and Southern Mississippi Valley Silty Uplands), and land resource area grouping 84, 84a, and 133 (Cross Timbers and Southern Coastal Plain) represent 10 percent, 33 percent, and 52 percent, respectively, of the total area with the problem. Acreage delineations for these LRA groupings by cropland, pasture, and woodland are presented in table 3.

Cropland use with regard to harvested, pastured, or not harvested nor pastured was determined by the Economic Research Service. The cropland and harvested cropland distributions commonly practiced in these land resource areas were used as the basis to determine the major crop distribution. Crop distributions are based on information from selected counties within these land resource areas. The principal sources of these data are the Census of Agriculture and Statistical Reporting Service.

A complete analysis of drainage and flood prevention improvement problems must include the effects on crops. The crop acreage delineations presented in table 3 show that the Texas Blackland Prairie (LRA 86) had an inadequate drainage and flood prevention improvement problem with cotton. Cotton is the major cash crop throughout this land resource area. 1/ In addition to cotton, small grains, grain sorghums, corn, grass, and other hay crops are also important as they relate to this water management problem.

Land resource area grouping 131 and 134 (Southern Mississippi Valley Alluvium and Silty Uplands LRA's) is an important cash-crop area in the Study Area. Approximately 28,400 acres of cotton have a drainage and flood prevention problem. This acreage may seem small in comparison to the total cotton acreage harvested within the Study Area; however, it must be recognized as a potential resource development. Large acreages of corn, soybeans, and hay are also grown in

---

1/ Land Resource Regions and Major Land Resource Areas of the United States, Agricultural Handbook 296, Soil Conservation Service, USDA, Washington, D. C., December 1965, page 38

TABLE 2B - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

Land Resource Area	Soils With A Drainage And Flood Problem				Soils With Adequate Drainage And Flood Prevention Improvement				Soils With Inadequate Drainage And Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(acres - thousands)											
84 and 84a	0.3	1.5	0.7	2.5	0	0	0	0	0.3	1.5	0.7	2.5
85	0.6	4.2	48.5	53.3	0.4	1.7	0.3	2.4	0.2	2.5	48.2	50.9
86	181.2	105.1	186.8	473.1	13.3	3.5	0	16.8	167.9	101.6	186.8	456.3
112	3.8	8.8	50.3	62.9	3.8	8.8	3.1	15.7	0	0	47.2	47.2
119	4.0	21.6	102.3	127.9	1.4	1.3	0	2.7	2.6	20.3	102.3	125.2
131	368.7	360.5	1,021.5	1,750.7	193.5	157.7	4.1	355.3	175.2	202.8	1,017.4	1,395.4
133	75.3	267.0	1,960.3	2,302.6	4.8	17.1	0.2	22.1	70.5	249.9	1,960.1	2,280.5
134	11.9	17.4	20.1	49.4	5.4	3.8	0	9.2	6.5	13.6	20.1	40.2
Grand Total	645.8	786.1	3,390.5	4,822.4	222.6	193.9	7.7	424.2	423.2	592.2	3,382.8	4,398.2

TABLE 3 - SOILS WITH INADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, BY LAND USE, AND MAJOR CROP DISTRIBUTION FOR THREE MAJOR LAND RESOURCE AREA GROUPINGS

Red River Basin Study Area, 1962

Crop	Inadequate Drainage and Flood Prevention Improvement				Study Area Total
	86	131, 134	84, 84a, 133	Subtotal	
	acres	acres	acres	acres	acres
Cropland:					
Harvested					
Cotton	45,655	28,406	2,740	76,801	-
Corn	13,105	16,038	3,452	32,595	-
Grain Sorghum	11,447	501	1,163	13,111	-
Soybeans	-	14,802	-	14,802	-
Oats	15,984	3,499	253	19,736	-
Alfalfa	5,970	4,162	344	10,476	-
Other hay	19,848	22,087	11,933	53,868	-
Total harvested	112,009	89,495	19,885	221,389	-
Pastured	32,751	71,487	39,671	143,909	-
Not harvested & not pastured	23,194	20,734	11,285	55,213	-
Total Cropland	167,954	181,716	70,841	420,511	423,207
Pasture	101,557	216,341	251,431	569,329	592,170
Woodland	186,806	1,037,568	1,960,740	3,185,114	3,382,842
Grand Total	456,317	1,435,625	2,283,012	4,174,954	4,398,219

this LRA grouping on "w" soils. Over 161,000 acres of cropland harvested and pastured are affected with a drainage and flood prevention improvement problem.

This water management problem affects the uplands' cropland pastured acreage to a greater extent than harvested cropland. Acreages of cropland in tame pastures and hay crops; e.g., alfalfa, other hay and cropland pastured, in LRA's 84, 84a, and 133 represent 73 percent of the harvested and pastured lands. Since cattle grazing and hay production is an important industry in this LRA grouping, the drainage and flood prevention improvement problem must be recognized as it relates to the agricultural economy in the upland areas in the entire Study Area.

Over 569,000 acres, or 96 percent, of the pasturelands having a drainage and flood prevention improvement problem are located in these three land resource area groupings. The problem is less severe on the pasturelands of LRA 86 with 101,600 acres, or 17 percent, of the total basin's pasture. LRA groupings 131 and 134, and 84, 84a, and 133 account for 37 percent and 42 percent, respectively, of the pasture having this water management problem. All other land resource areas' pasture amounts to only 4 percent.

DRAINAGE AND FLOOD PREVENTION DEVELOPMENT FEASIBILITY

Physical and economic factors were considered in the development of soils feasible for drainage and flood prevention improvement. Soils with inadequate drainage and flood prevention improvement located at elevations that would be very difficult to correct were not considered feasible for drainage and flood prevention improvement. Land use information was developed for selected land resource areas in the Study Area. Costs and returns from drainage and flood prevention improvement, crop yields, technology, and production costs have a vital part in establishing feasibility.

Generally, woodland drainage for woodland benefit is not considered feasible in the Study Area.

There are 4,398,200 acres of flatland soils with inadequate drainage and flood prevention improvement. Over 3,118,700 acres are not feasible for drainage and flood prevention improvement, while 1,279,500 acres are feasible for these types of improvements.

FACTORS AFFECTING FEASIBILITY

Physical Factors

Land use information was developed for selected land resource areas in the Study Area by applying the average land use distribution and cropping pattern for that acreage of agricultural flatland

found to have inadequate drainage and flood prevention improvement under 1962 conditions. The land resource areas selected and their groupings are: (1) Texas Blackland Prairie (86); (2) Southern Mississippi Valley Alluvium (131) and the Southern Mississippi Valley Silty Uplands (134); and (3) Southern Coastal Plain (133) and Cross Timbers (84 and 84a). (The third land resource area grouping is referred to as "uplands.")

These three groupings account for 99 percent of the cropland, 96 percent of the pasture, and 94 percent of the woodland soils with inadequate drainage and flood prevention improvement.

Acreages with inadequate drainage and flood prevention improvement which show the estimated land uses for these selected land resource area groupings were presented in table 3. Cropland was further disaggregated into harvested, pastured, and not harvested and not pastured areas.

Harvested cropland was apportioned into the major crops by the average basin cropping pattern for each land resource area grouping designated above. Cotton, hay, and corn acreages are the greatest cropland uses affected by inadequate drainage and flood prevention improvement. Soybeans are produced on the alluvium soils only. The drainage and flood problem limitation on soybean acreage is surpassed only by cotton, hay crops, and corn in the alluvium grouping.

There were acreages of soils included in the drainage and flood prevention inventory solely because of frequent flooding. These soils are normally permeable. Elimination of the flood problem would eliminate the need for drainage. For this reason, these soils are not considered in the acreage of soils feasible for drainage and flood prevention improvement.

In the Southern Mississippi Valley Alluvium Land Resource Area (131), soils located in "old river runs" and small "ox bow" lakes with a drainage and flood problem were considered not feasible for improvement. These soils are located at an elevation which would require excessive overcutting of channels for proper functioning. Acreages in this category were estimated by the SCS based on their knowledge of the area. Areas frequently flooded by high stages on Red River also were excluded from the feasible category.

Economic Factors

To evaluate the economic feasibility of drainage and flood prevention improvement on flatlands, it is necessary to have both costs and returns from drainage and flood prevention improvement. Sufficient information to permit a complete costs and returns

evaluation of drainage and flood prevention of land resource areas was not available. However, some insight into the economics of the problem can be gained by estimating the yield responses necessary to cover the costs of removing this wetness, or excess water limitation. In addition to the direct cost of drainage and flood prevention improvement, there are usually associated costs with its use. An example of these associated costs is the expense of harvesting and processing any increase in yields. Estimates of production responses over and above associated costs for drainage and flood prevention improvement, and associated costs for selected crops, are presented in this analysis. This analysis does not include enhancement and land use conversion. It is based solely on the acreages of land with a wetness hazard.

About 3.1 million acres of land classed as needing drainage and flood prevention improvement are classed as not economically feasible under normalized prices and projected needs for food and fiber. The improvement in productivity would not repay the costs of drainage under this price structure. Should greater needs for food and fiber become evident, it could be expected that drainage of portions of this land would become profitable under the improved price relationship.

Representative costs of structural measures for drainage and flood prevention improvement on flatlands are presented in table 4. Installation, annual maintenance, and annual equivalent costs are tabulated separately for cropland and pastureland. These are currently used for estimating purposes.

Crop Yields and Technology

Yield estimates for crops and pasture, both with and without adequate drainage and flood prevention improvement, were developed for all major land uses and crops. An average yield was determined for each major crop within the land resource area groupings. Increases in yields that might be accomplished through application of technology alone were not reflected in these data. Yields are based on typical soils for each land resource area grouping which have a wetness limitation in an average year with good management. However, benefits from drainage and flood prevention improvement were calculated using estimated yields with drainage and flood prevention improvement and advanced technology. Estimates of crop and pasture yields under the various conditions are presented in table 5 for the three land resource area groupings.

Increase in yield can be expected from installation of drainage and flood prevention structural measures on flatlands. These vary widely due to soil type, crops grown, level of management, and seriousness of excess water problem. Tables 6 and 7 present examples of yields, production costs, and net returns with and without drainage

TABLE 4 - CURRENT PER ACRE COSTS OF DRAINAGE AND FLOOD PREVENTION IMPROVEMENT ON FLATLANDS

Red River Basin Study Area

Land Use and Proposed Land Improvements	Installation Costs: On-farm Drainage and Flood Prevention Improvement	Installation Costs: Group Drainage and Flood Prevention Improvement	Installation Costs: Total	Annual Costs: Maintenance: On-farm	Annual Costs: Maintenance: Group	Annual Costs: Amortized Installation Costs 1/
	(Dollars)					
Cropland						
Excavation 2/	10.25	4.00	14.25	-	-	-
Drainage and Flood Prevention Improvement Structures	4.00	3.00	7.00	-	-	-
Total	14.25	7.00	21.25	1.40	0.50	2.25
Pasture						
Excavation 2/	6.50	4.00	10.50	-	-	-
Drainage and Flood Prevention Improvement Structures	3.00	3.00	6.00	-	-	-
Total	9.50	7.00	16.50	0.50	0.50	1.64

1/ Based on 10 years @ 5 percent interest for on-farm drainage and flood prevention improvement and 25 years @ 3-1/8 percent interest for group drainage and flood prevention improvement.

2/ Excavation cost estimated at $0.25 per yard.

and flood prevention measures used in development of two watershed work plans under Public Law 566, as amended. These plans are the Haney Creek Watershed located in Arkansas, and the Waterfall-Gilford Creek Watershed located in Oklahoma.

TABLE 5 - AVERAGE YIELDS: INADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, AND ADEQUATE DRAINAGE AND FLOOD PREVENTION IMPROVEMENT CONDITIONS WITH GOOD MANAGEMENT AND ADVANCED TECHNOLOGY, BLACKLANDS, ALLUVIUM-SILTY UPLANDS, AND UPLANDS

Red River Basin Study Area

Crops	Unit	Land resource areas	Average yields: Inadequate drainage and flood prevention improvement (good management)	Average yields: Adequate drainage and flood prevention improvement (Advanced technology)
Corn	Bu.	Blacklands	32	41
		Alluvium	40	58
		Uplands	30	43
Cotton	Lb.	Blacklands	222	350
		Alluvium	340	575
		Uplands	200	300
Soybeans	Bu.	Alluvium	23	34
Oats	Bu.	Blacklands	30	48
		Alluvium	30	53
		Uplands	30	37
Gr.sorghums	Bu.	Blacklands	36.5	51.0
		Alluvium	35.0	53.0
		Uplands	30.0	44.0
Alfalfa	Ton	Blacklands	2.1	2.4
		Alluvium	2.3	3.5
		Uplands	2.0	2.2
Other hay	Ton	Blacklands	1.5	2.5
		Alluvium	1.5	3.0
		Uplands	1.0	1.5
Pasture	AUM	Blacklands	3.5	4.5
		Alluvium	4.0	5.1
		Uplands	1.8	2.4

TABLE 6 - PER ACRE YIELDS WITHOUT AND WITH DRAINAGE AND FLOOD PREVENTION IMPROVEMENT IN SELECTED WATERSHEDS

Red River Basin Study Area

Crop	Unit	YIELDS			
		Haney Creek Watershed, Arkansas		Waterfall-Gilford Creek Watershed, Oklahoma	
		Without Project	With Project	Without Project	With Project
Corn	Bu.	-	-	46	57
Cotton	Lbs.Lint	360	525	489	643
Soybeans	Bu.	19	28	27	33
Oats	Bu.	40	50	-	-
Gr.Sorghum	Cwt.	-	-	17	28
Alfalfa	Ton	-	-	3.0	3.5
Oats, pasture	AUM	3.0	7.0	-	-
Pasture	AUM	3.0	6.5	-	-
Improved pasture	Lbs.Beef	-	-	214	320

Technology as considered in this evaluation includes week and insect control, improved varieties of seed, improved cultural practices, the increased use of fertilizers, etc. Yield increases which could be obtained from applied technology on flatland soils with inadequate drainage and flood prevention improvement would be very limited as compared with what technology would accomplish under adequate drainage and flood prevention improvement conditions.

In general, the effect of drainage and flood prevention improvement will result in increased yield due to less loss at harvest, increased effectiveness of fertilizers, more favorable growing conditions, cropping of formerly idle areas, more timely field operations, and greater efficiency.

An increase in machinery efficiency can be expected due to fewer replantings, a lesser number of farming operations, less lost time with heavy equipment, and less maintenance due to mud and lighter draw-bar pull.

Production Costs and Returns

Expenses involved in producing each major crop being grown in a land resource area grouping were calculated using the "adjusted

TABLE 7 - PRODUCTION COSTS, NET RETURNS, AND PER ACRE INCREASES WITH DRAINAGE AND FLOOD PREVENTION IMPROVEMENT, ADJUSTED NORMALIZED PRICES

Red River Basin Study Area

Watersheds and Crop Distribution	Without Project			With Project			Increase Per Acre Due to Project Development
	Gross Income	Production Costs	Net Returns	Gross Income	Production Costs	Net Returns	
	(dollars)						
Haney Creek Watershed (Arkansas)							
Cotton	127.07	103.40	23.67	185.38	120.84	64.54	40.87
Soybeans	54.79	20.73	34.06	80.76	21.19	59.57	25.51
Oats	29.90	18.03	11.87	37.38	18.54	18.84	6.97
Oats, pasture	8.60	-	8.60	20.07	-	20.07	11.47
Pasture	10.60	2.46	8.14	18.63	1.87	16.76	8.62
Waterfall-Gilford Creek Watershed (Oklahoma)							
Cotton	129.95	122.20	7.75	171.03	134.88	36.15	28.40
Soybeans	61.51	27.51	34.00	75.12	27.70	47.42	13.42
Corn	50.90	30.34	20.56	63.18	31.47	31.71	11.15
Grain Sorghum	27.01	16.06	10.95	45.19	19.17	26.02	15.07
Alfalfa	74.14	32.48	41.66	90.78	38.52	52.26	10.60
Improved pasture	17.50	12.26	5.24	26.22	15.45	10.77	5.53

normalized prices." Adjusted normalized prices received for specific commodities in the four-state area are presented in table 8. These prices are an average for the four states; i.e., Arkansas, Louisiana, Oklahoma, and Texas. Costs and returns estimates are based on a single set of price assumptions. Individuals using these price data may wish to refer to the "Interim Price Standards for Planning and Evaluating Water and Land Resources" to adjust presented production budgets, to be more nearly accurate for a specific situation or area.

Production cost and return data for individual crops in the "bottomland" and "upland" soils without drainage and flood prevention improvements and good management, and soils with drainage and flood prevention improvements with advanced technology are presented as exhibits 3A to 12B. Production cost data for the Texas Blackland Prairie LRA (86) were limited. Costs and yields data for this LRA were determined from the Texas Drainage Survey Report. Table 9 is a summarization of the adjusted normalized costs and returns for the major crops in the three land resource area groupings.

The crop production cost data presented in the exhibits point up different production practices followed under conditions of adequate and inadequate drainage and flood prevention improvement, and these are reflected in the expenses incurred for producing a particular crop. Additional plantings, insecticides, and other production practices - either practiced by the farm operator with drained conditions or disregarded because of wet lands - influence the costs of production for each major crop. Hay crops, in general, do not require replanting.

Increased yields under adequate drainage and flood prevention improvement conditions usually are the result of added production costs and a higher quality of land management by the operator. Benefits from adequate drainage and flood prevention improvement include better bacterial action, early warm-up of soil in the spring, and makes the use of modern equipment more efficient, which, in turn, affects production practices and costs. No changed land use and enhancement benefits have been identified in this analysis.

In general, the effect of adequate drainage and flood prevention improvement on cropland has been found to result in (1) an increase in harvested yields, (2) an increase in machinery efficiency, (3) an increase in quality of harvested crops, (4) greater adaptability of mechanization, and (5) a shift to more valuable crops.

DRAINAGE AND FLOOD PREVENTION IN FOREST MANAGEMENT

Normally, natural forest cover developing on low, flat areas, or on poorly drained soils is that best adapted to the site. Timber

Table 8 - Prices: Adjusted normalized for specific commodities, Arkansas, Louisiana, Oklahoma, Texas, and 4-state average, Red River Basin Study Area 1/

Commodity	Unit	Arkansas	Louisiana	Oklahoma	Texas	4-State Average 1/
		Dols.	Dols.	Dols.	Dols.	Dols.
Wheat	Bu.	1.27	1.27	1.31	1.31	1.29
Rice	Cwt.	4.75	4.75	-	4.84	4.78
Corn	Bu.	1.17	1.21	1.11	1.17	1.16
Oats	Bu.	.68	.73	.63	.68	.68
Barley	Bu.	.84	-	.79	.84	.82
Sorghums	Bu.	1.11	1.11	.95	.95	1.04
Cotton, lint	Lb.	.26	.25	.23	.24	.24
Cottonseed	Ton	47.04	46.08	47.04	48.00	47.04
Soybeans	Bu.	2.47	2.30	2.25	2.25	2.32
Potatoes	Cwt.	3.20	2.55	3.20	2.87	2.95
Sweet Potatoes	Cwt.	4.52	2.57	5.03	4.52	4.16
Hay, all 2/	Ton	23.54	24.64	22.66	24.20	23.76
Alfalfa 2/ 3/	Ton	29.26	33.33	25.98	30.27	29.71
Cattle	Cwt.	18.04	16.40	19.48	18.45	18.09
Calves	Cwt.	22.56	23.04	24.00	23.04	23.16
Sheep	Cwt.	5.47	5.98	5.98	7.52	6.23
Lambs	Cwt.	16.02	15.12	17.64	15.12	15.97
Hogs	Cwt.	15.05	14.44	15.05	15.05	14.89
Commercial Broilers	Lb.	.13	.14	.14	.14	.14
Turkeys	Lb.	.20	.22	.19	.20	.20
Eggs	Doz.	.38	.40	.30	.34	.35

Source: Interim Price Standards for Planning and Evaluating Water and Land Resources, Interdepartmental Staff Committee of the Water Resources Council, Washington, D. C., April 1966.

1/ The prices presented are an average for the four states in the basin complex.
2/ Price of hay sold baled.
3/ Alfalfa hay price was computed by ERS, Little Rock, Arkansas.

Table 9. - Summary, per acre production costs and returns: Adjusted normalized income, expenses, and net returns, with and without drainage and flood prevention improvements, and reduction in net income due to inadequate drainage and flood prevention improvement, Red River Basin Study Area

Crops	Land Resource Areas	Soils With Adequate Drainage Improvement and Flood Prevention 1/			Soil With Inadequate Drainage Improvement Flood Prevention 2/			Loss Per Acre Due to Inadequate Drainage and Flood Prevention Improvement
		Gross Income	Expenses	Net Return	Gross Income	Expenses	Net Return	
		Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.
Corn	86	47.56	45.88	1.68	37.12	44.68	- 7.56	9.24
	131, 134	67.28	41.26	26.02	46.40	39.66	6.74	19.28
	133	49.88	40.78	9.10	34.80	34.65	.15	8.95
Cotton	86	98.62	86.15	12.47	62.57	74.19	-11.62	24.09
	131, 134	162.02	129.22	32.80	95.81	93.02	2.79	30.01
	133	84.53	92.89	- 8.36	56.35	65.55	- 9.20	0.84
Soybeans	131, 134	78.88	23.59	55.29	53.36	21.65	31.71	23.58
Oats	86	32.64	22.32	10.32	20.40	22.24	- 1.84	12.16
	131, 134	36.04	28.02	8.02	20.40	28.57	- 8.17	16.19
	133	25.16	25.04	0.12	20.40	25.96	- 5.56	5.68
Grain Sorghums	86	53.04	34.63	18.41	37.96	27.63	10.33	8.08
	131, 134	55.12	33.60	21.52	36.40	25.26	11.14	10.38
	133	45.76	29.73	16.03	31.20	24.24	6.96	9.07

Table 9. - Summary, per acre production costs and returns: Adjusted normalized income, expenses, and net returns, with and without drainage and flood prevention improvements, and reduction in net income due to inadequate drainage and flood prevention improvement, Red River Basin Study Area - (cont'd)

Crops	Land Resource Areas	Soils With Adequate Drainage Improvement and Flood Prevention 1/			Soil With Inadequate Drainage Improvement Flood Prevention 2/			Loss Per Acre Due to Inadequate Drainage and Flood Prevention Improvement
		Gross Income	Expenses	Net Return	Gross Income	Expenses	Net Return	
		Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.
Alfalfa	86	71.30	49.00	22.30	62.39	48.00	14.39	7.91
	131, 134	103.98	48.97	55.01	68.33	38.26	30.07	24.94
	133	68.33	49.95	18.38	59.42	48.45	10.97	7.41
Other hay	86	59.40	35.07	24.33	35.64	23.47	12.17	12.16
	131, 134	71.28	39.69	31.59	35.64	23.47	12.17	19.42
	133	35.64	25.89	9.75	23.76	23.47	.29	9.46
Pasture	86	32.40	17.00 3/	15.40	25.20	12.00 3/	13.20	2.20
	131, 134	36.72	19.00 3/	17.72	28.80	12.35 3/	16.45	1.27
	133	17.28	15.08 3/	2.20	12.96	12.04 3/	.92	1.28

1/ Advanced technology is considered with adequate drainage and flood prevention improvement soil conditions.
2/ Good management and present technology are considered with soils with inadequate drainage and flood prevention improvement.
3/ ACP payments were not included.

species adapted to such wet sites can make normal growth where the aerated root zone is no more than 10 to 12 inches during the growing season. Some species of commercial value, such as Bald Cypress and Tupelo Gum make best growth on ponded sites or in flowing water.

To increase drainage and flood prevention improvement on such areas may result in unthrifty conditions or reduced growth for species occupying such sites. Throughout almost all of the Red River Basin Study Area where low, wet forest areas have been reasonably well-managed, commercial timber production is possible, and increasingly profitable as market conditions for bottomland species steadily improve. Under ownership dedicated to forest production, drainage and flood prevention improvement must be justified by increased return, or reduced management costs.

Where natural drainage has been altered on low-lying forest areas, drainage and flood prevention improvements may be desirable or necessary. Drainage and flood prevention channels filled with accumulated sediment or obstructed by levees or highway embankments will result in adverse and usually undesirable site changes. A forest operator may have to improve or restore drainage and flood prevention improvements to maintain the desired timber species and growth rates. In other situations where drainage and flood prevention improvement is considered on managed forest lands, a careful study should be made before the existing condition is altered to determine as closely as possible the ultimate effects on the existing timberstand, or the potential of the new stand may result from altered site conditions.

Research on forest drainage in the Coastal Plain has shown benefits to drainage of wet pine land sites. Retaining desired timber species and improving growth rates may require restoring drainage and flood improvements which have been altered by accumlated sediment or cultural improvements. Sites which would benefit from woodland drainage are so sparsely located within the Study Area that they were not included in the inventory of soils feasible for drainage and flood improvements. Therefore, woodland drainage for woodland benefits is not considered feasible in the Study Area.

SUMMARY OF LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY

Drainage and flood prevention improvement feasibility by land use and tributary basin is presented in table 10. The soils with inadequate drainage and flood prevention are divided into two categories; soils not feasible for drainage and flood prevention improvement and soils feasible for drainage and flood prevention improvement.

As explained in the discussion of table 2, the tabulation of acreage with inadequate drainage and flood prevention improvement is from a soil physical property basis only. Land use has no effect on what acreage appears in this category.

Land use and land resource area are given consideration in determining the acreages in table 10 that are feasible and not feasible for drainage and flood prevention improvement. Feasibility is limited mainly to the Texas Blackland Prairie (86) and Southern Mississippi Valley Alluvium (131) Land Resource Areas. Feasibility of improvement of soils with a drainage and flood problem in the Texas Blackland Prairie (86) and Southern Coastal Plain (133) Land Resource Areas in Texas was based on the 1965 Texas Drainage Survey Report. Exclusion of Southern Coastal Plain (133) soils in other states, as well as other land resource areas in all states, was based on records of soils with adequate drainage and flood prevention improvement. Woodland drainage for woodland benefit is not considered feasible in the Study Area. Any soils that are in woodland and feasible for drainage would be feasible only if there were a corresponding change in land use.

Of the 4,398,200 acres with inadequate drainage and flood prevention improvement 3,118,700 acres are not feasible for drainage and flood prevention improvement and 1,279,500 acres are feasible.

A subdivision of the tributary basin acreages, presented in table 10, into States and land resource areas is presented in exhibit 13.

Table 10 data are summarized by land use, state and land resource area in table 10A. The 3,118,700 acres of soils not feasible for drainage and flood prevention improvement are divided as follows: Arkansas - 648,800 acres; Louisiana - 1,091,900 acres; Oklahoma - 316,200 acres; and Texas - 1,061,800 acres. The 1,279,500 acres of soils feasible for drainage and flood prevention improvement are divided as follows: Arkansas - 197,100 acres; Louisiana - 708,200 acres; Oklahoma - 88,500 acres; and Texas - 285,700 acres. Table 10 data are summarized by land use and land resource area in table 10B.

APPRAISAL OF POTENTIAL FOR DRAINAGE AND FLOOD PREVENTION DEVELOPMENT

The purpose of drainage and flood prevention improvement is to keep soils productive with a corresponding minimum soil depletion. The greatest drainage and flood prevention improvement potential in the Red River Basin is located in the Southern Mississippi Valley Alluvium (131) and the Southern Mississippi Valley Silty Uplands (134) Land Resource Areas.

TABLE 10 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE AND TRIBUTARY BASIN

Red River Basin Study Area, 1962

Tributary Basin	Soils With Inadequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total	Soils Not Feasible for Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total	Soils Feasible for Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total
	(acres - thousands)											
Barkman Creek	3.6	1.8	14.2	19.6	0	0.4	8.2	8.6	3.6	1.4	6.0	11.0
Bayou Jean de Jean	0.2	0.5	16.6	17.3	Z	Z	16.0	16.0	0.2	0.5	0.6	1.3
Bayou Pierre	17.7	52.9	165.3	235.9	1.1	22.8	123.3	147.2	16.6	30.1	42.0	88.7
Bayou Rapides	4.4	10.5	8.8	23.7	0	0	1.6	1.6	4.4	10.5	7.2	22.1
Bayou Rigolette	2.7	6.2	47.6	56.5	0	0.7	33.7	34.4	2.7	5.5	13.9	22.1
Black and Saline Lakes	1.2	14.2	172.6	188.0	0.5	7.7	165.7	173.9	0.7	6.5	6.9	14.1
Blue River	1.0	2.2	10.7	13.9	0.5	2.2	10.7	13.4	0.5	0	0	0.5
Boggy Creek	9.4	4.0	102.3	115.7	2.7	4.0	96.0	102.7	6.7	0	6.3	13.0
Bois d' Arc Creek	0.8	3.8	31.7	36.3	0	0	22.2	22.2	0.8	3.8	9.5	14.1
Cane River	0.7	10.2	110.6	121.5	0.4	1.1	66.3	67.8	0.3	9.1	44.3	53.7
Chatlin Lake and Associated Area	15.9	35.0	231.2	282.1	0	0.9	8.9	9.8	15.9	34.1	222.3	272.3
Cypress Creek	36.3	87.0	337.1	460.4	19.9	71.6	322.1	413.6	16.4	15.4	15.0	46.8
Kiamichi River	2.8	24.6	75.1	102.5	0	23.7	70.7	94.4	2.8	0.9	4.4	8.1
Little River	7.6	35.9	298.4	341.9	2.8	26.2	267.0	296.0	4.8	9.7	31.4	45.9
Loggy Bayou	30.6	35.6	516.4	582.6	2.7	24.5	498.9	526.1	27.9	11.1	17.5	56.5
Maniece Bayou	2.7	8.2	20.7	31.6	0.8	0.7	8.5	10.0	1.9	7.5	12.2	21.6
McKinney Bayou	9.8	6.0	71.4	87.2	2.1	3.3	12.7	18.1	7.7	2.7	58.7	69.1
Intervening Areas - Ark. and Okla.	21.7	43.6	85.4	150.7	0.1	6.9	50.4	57.4	21.6	36.7	35.0	93.3
Intervening Areas - Tex.	95.3	35.0	227.1	357.4	48.1	9.2	150.6	207.9	47.2	25.8	76.5	149.5
Nantachie Creek	0	0.3	10.1	10.4	0	0.3	10.1	10.4	0	0	0	0
Posten Bayou	10.6	4.2	15.9	30.7	0.2	1.0	7.5	8.7	10.4	3.2	8.4	22.0
Red River Backwater Area	10.9	19.6	363.3	393.8	0	2.0	283.8	285.8	10.9	17.6	79.5	108.0
Red River Main Stem	5.8	20.5	72.1	98.4	0.2	3.6	58.5	62.3	5.6	16.9	13.6	36.1
Sulphur	131.5	130.4	378.2	640.1	100.9	84.6	344.9	530.4	30.6	45.8	33.3	109.7
Grand Total	423.2	592.2	3,382.8	4,398.2	183.0	297.4	2,638.3	3,118.7	240.2	294.8	744.5	1,279.5

Z = Too small to be reported.

TABLE 10A - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

State and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(acres - thousands)											
Arkansas												
86	5.5	5.2	4.8	15.5	0	0	2.1	2.1	5.5	5.2	2.7	13.4
119	0	0.8	23.6	24.4	0	0.8	23.6	24.4	0	0	0	0
131	22.2	20.1	144.6	186.9	0	0	15.7	15.7	22.2	20.1	128.9	171.2
133	10.2	40.6	568.3	619.1	8.5	35.8	562.3	606.6	1.7	4.8	6.0	12.5
Total	37.9	66.7	741.3	845.9	8.5	36.6	603.7	648.8	29.4	30.1	137.6	197.1
Louisiana												
131	96.7	139.3	784.9	1,020.9	0	2.9	342.2	345.1	96.7	136.4	442.7	675.8
133	2.8	66.3	669.9	739.0	2.8	66.3	669.9	739.0	0	0	0	0
134	6.5	13.6	20.1	40.2	0	0.9	6.9	7.8	6.5	12.7	13.2	32.4
Total	106.0	219.2	1,474.9	1,800.1	2.8	70.1	1,019.0	1,091.9	103.2	149.1	455.9	708.2
Oklahoma												
84 and 84a	0.3	1.5	0.7	2.5	0.3	1.5	0.7	2.5	0	0	0	0
85	0.2	2.5	48.2	50.9	0.2	2.5	48.2	50.9	0	0	0	0
86	0.5	0.3	0.1	0.9	0	0	0	0	0.5	0.3	0.1	0.9
112	0	0	47.1	47.1	0	0	47.1	47.1	0	0	0	0
119	2.6	19.5	78.8	100.8	2.6	19.5	78.7	100.8	0	0	0	0
131	23.4	30.4	34.2	88.0	0	0	3.7	3.7	23.4	30.4	30.5	84.3
133	0.2	21.7	92.6	114.5	0.2	19.2	91.8	111.2	0	2.5	0.8	3.3
Total	27.2	75.9	301.6	404.7	3.3	42.7	270.2	316.2	23.9	33.2	31.4	88.5
Texas												
86	161.9	96.0	181.9	439.8	126.3	67.1	164.8	358.2	35.6	28.9	17.1	81.6
131	32.9	13.0	53.8	99.7	0	0	0	0	32.9	13.0	53.8	99.7
133	57.3	121.4	629.3	808.0	42.1	80.9	580.6	703.6	15.2	40.5	48.7	104.4
Total	252.1	230.4	865.0	1,347.5	168.4	148.0	745.4	1,061.8	83.7	82.4	119.6	285.7
Grand Total	423.2	592.2	3,382.8	4,398.2	183.0	297.4	2,638.3	3,118.7	240.2	294.8	744.5	1,279.5

TABLE 10B - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	(acres - thousands)											
84 and 84a	0.3	1.5	0.7	2.5	0.3	1.5	0.7	2.5	0	0	0	0
85	0.2	2.5	48.2	50.9	0.2	2.5	48.2	50.9	0	0	0	0
86	167.9	101.6	186.8	456.3	126.3	67.2	166.9	360.4	41.6	34.4	19.9	95.9
112	0	0	47.2	47.2	0	0	47.2	47.2	0	0	0	0
119	2.6	20.3	102.3	125.2	2.6	20.3	102.3	125.2	0	0	0	0
131	175.2	202.8	1,017.4	1,395.4	0	2.9	361.5	364.4	175.2	199.9	655.9	1,031.0
133	70.5	249.9	1,960.1	2,280.5	53.6	202.1	1,904.6	2,160.3	16.9	47.8	55.5	120.2
134	6.5	13.6	20.1	40.2	0	0.9	6.9	7.8	6.5	12.7	13.2	32.4
Grand Total	423.2	592.2	3,382.8	4,398.2	183.0	297.4	2,638.3	3,118.7	240.2	294.8	744.5	1,279.5

There are 807,300 acres with a potential for group drainage and flood prevention development in the Study Area. Of this total, there are 699,000 acres identified for potential development by 1980 and 108,300 acres identified for long-term potential development.

There are 1,279,500 acres considered to have a potential for on-farm drainage and flood prevention improvement. There are 472,200 acres of this on-farm potential on which drainage and flood prevention improvement could be accomplished without development of group outlets; group outlets are already in existence or not needed in these areas.

DRAINAGE AND FLOOD PREVENTION OUTLET CHANNELS

Acreages of soils with a drainage and flood problem having adequate outlets, as indicated under definitions, are those areas where adequate main outlet channels are available or can be reached by on-farm or group drainage and flood prevention improvements. Generally, an area is considered to have an adequate outlet if the drainage area of the project has not exceeded 250,000 acres by the time an adequate main outlet channel (example - Red River) is reached. Where this drainage area is exceeded before reaching an adequate main outlet channel, the area is considered to have an inadequate outlet.

There are three tributary basins with soils feasible for drainage and flood prevention improvement in which there are inadequate outlets. They are Bayou Rigolette, Chatlin Lake and Associated Area, and Sulphur River.

Preliminary investigations indicated that Bayou Rigolette and the outlet structure at the mouth of Bayou Rigolette are inadequate. Further studies are contemplated to determine outlet needs. Results of these studies will appear in the Plan Formulation appendix.

The U. S. Army Engineers are presently making investigations and planning needed drainage and flood prevention improvement of main outlet channels in the Chatlin Lake and Associated Area.

Sulphur River between the mouth and the junction of North and South Sulphur Rivers is inadequate. The U. S. Army Engineers have an authorized project for channel improvement between the upper end of Lake Texarkana and the junction of North and South Sulphur Rivers. Sulphur River tentative development plans as a part of the Texas Water Plan contemplate reservoir construction that would inundate much of the area affected by this authorization. Therefore, major modification of the USAE authorized project is likely.

ECONOMIC FACTORS

The damages due to inadequate drainage and flood prevention improvements in this appendix cover an appraisal of the agricultural values and costs that could be expected if these water management problems were alleviated and suitable measures installed. It was assumed that the proposed projects would provide complete and adequate outlet facilities for both surface and subsurface drainage and flood prevention of the areas to be served by the farm and group systems projected herein.

Benefits from Increases in Crop Production

Benefits from increases in crop production expected to result from drainage and flood prevention improvements were limited to the increases in net crop income. Consequently, increases in associated income such as labor income resulting from harvesting the more abundant crop, added profits to business in the Red River Basin derived from increased production, increased taxes resulting from high land value, etc., were not included.

The benefits from abatement of drainage and flood damages were the difference between the estimated net returns expected to occur after complete drainage and flood prevention improvement installation and those estimated for existing (without project) conditions. Estimated land uses and yields achieved with and without project conditions were converted to terms of average annual reduction in net incomes.

Production Responses Necessary to Cover Drainage and Flood Prevention Improvement Costs

Budgeting of crop inputs and outputs can be used to estimate the profitable changes in cropland land use implied by a water management problem. In the simplest form, the results of budgeting are approximations. However, some insight into the economics of the problem can be gained by estimating the yield responses necessary to cover the costs of removing this limitation factor.

In general, the potential benefits from the installation of drainage and flood prevention improvement measures on land with inadequate drainage and flood prevention at present, are realized by the increase in returns from agricultural production. The evaluation of data in table 11 has shown what the estimated net returns are for those lands considered to have inadequate drainage and flood prevention improvement. The assumption was followed that all drainage and flood prevention improvements would be installed during the time period of the comprehensive study or by

1980 and long-term project development. Determination of the rate and extent of installation is left to the engineers, or users of these data. Therefore, neither the benefits nor costs of land use conversions presented in this evaluation have been discounted for any lag after installation of the drainage and flood prevention facilities. The potential net returns and losses per acre due to inadequate drainage and flood prevention improvement are summarized in table 9 for the major crops by land resource area groupings. Production costs and gross income are also presented in the summarized table. The estimated average annual reduction in net income in the Red River Basin from inadequate drainage and flood prevention improvement in these three land resource area groupings (table 11) is approximately $4.3 million. This reduction in net income from 423,200 acres of cropland alone with inadequate drainage and flood prevention improvement is approximately $10 per acre.

TABLE 11 - POTENTIAL NET RETURNS, DRAINAGE AND FLOOD PREVENTION IMPROVEMENT: CROPLAND HARVESTED AND PASTURED, BY MAJOR CROPS SELECTED LAND RESOURCE AREA GROUPINGS

Red River Basin Study Area

Crop	Damages due to inadequate drainage and flood prevention improvement			
	86	131, 134	84, 84a, 133	Total
	Dollars	Dollars	Dollars	Dollars
Harvested Cropland				
Cotton	1,099,829	852,464	2,302	1,954,595
Corn	121,090	309,213	30,895	461,198
Grain sorghum	92,492	5,200	10,548	108,240
Soybeans	-	349,031	-	349,031
Oats	194,365	56,649	1,437	252,451
Alfalfa	47,223	103,800	2,549	153,572
Other hay	241,352	428,930	112,886	783,168
Subtotal	1,796,351	2,105,287	160,617	4,062,255
Pastured Cropland	72,052	90,788	50,779	213,619
Total	1,868,403	2,196,075	211,396	4,275,874

An $11 per acre reduction in net annual income from cropland with inadequate drainage and inadequately drained flood prevention improvement is realized in the Texas Blackland Prairie (86) grouping, $12 in the Southern Mississippi Valley Alluvium (131) and Southern

Mississippi Valley Silty Uplands (134) grouping, and less than 43 in the Cross Timbers (84 and 84a) and Southern Coastal Plain (133) grouping.

POTENTIAL DRAINAGE AND FLOOD PREVENTION DEVELOPMENT

Potential group drainage and flood prevention development by tributary basin - 1980 and long-term - is presented in table 12. Total potential development is based on results of field investigations. Potential group drainage and flood prevention development is subdivided into project-type and nonproject-type. Potential project-type development by 1980 was determined after consultation with the concerned states. The remaining project-type development was shown as long-term potential development. Acreages of potential project-type drainage and flood prevention development represents specific conservation needs inventory watershed projects within the tributary basins. These projects will be identified in the Upstream Watershed Protection, Use, Management, and Development appendix. The division of potential nonproject-type drainage and flood prevention development between 1980 and long-term was estimated.

There are 807,300 acres with a potential for group drainage and flood prevention development in the Study Area. Of this total, there is a potential for project development on 596,300 acres and a potential for nonproject development on 211,000 acres. There are 699,000 acres identified for potential development by 1980 and 108,300 acres identified for long-term potential development.

Project-type group drainage and flood prevention development can be accomplished by local interests with the assistance of the Soil Conservation Service under the Public Law 566 program. Nonproject-type group drainage and flood prevention development can be accomplished by local interests with the assistance of the Soil Conservation Service under the Public Law 46 program. Some of this work also could be done by other Federal or State agencies.

Data given in table 12 do not reflect acreages of soils with a drainage and flood problem that presently have adequate channel improvement, but will need enlargement in the future. This need for enlargement will be caused by changed land use in these areas. More land is being cleared and put into production and this will increase the rainfall runoff. This cleared acreage will need a higher degree of protection than presently afforded. Some of the adequately drained lands may require further improvement because of improper maintenance or because of a change in standards for drainage as a result of changing agriculture. Potential project development is anticipated in these areas, but it is not shown in this report. The data in this report reflect potential based on 1962 conditions.

TABLE 12 - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL - 1980 AND LONG-TERM - BY TRIBUTARY BASIN

Red River Basin Study Area

Tributary Basin	Total Group Drainage and Flood Prevention Potential	1980			Long-Term		
		Project	Non-Project	Total	Project	Non-Project	Total
	(acres - thousands)						
Barkman Creek	5.7	5.7	0	5.7	0	0	0
Bayou Jean de Jean	0	0	0	0	0	0	0
Bayou Pierre	15.5	0	7.8	7.8	2.5	5.2	7.7
Bayou Rapides	21.7	0	13.0	13.0	0	8.7	8.7
Bayou Rigolette	15.0	15.0	0	15.0	0	0	0
Black and Saline Lakes	0	0	0	0	0	0	0
Blue River	0.5	0	0.5	0.5	0	0	0
Boggy Creek	1.0	0	0.6	0.6	0	0.4	0.4
Bois d' Arc Creek	4.0	0	0	0	4.0	0	4.0
Cane River	7.8	0	4.7	4.7	0	3.1	3.1
Chatlin Lake and Associated Area	249.0	237.0	7.2	244.2	0	4.8	4.8
Cypress Creek	7.4	0	4.4	4.4	0	3.0	3.0
Kiamichi River	5.4	5.4	0	5.4	0	0	0
Little River	3.0	0	0	0	3.0	0	3.0
Loggy Bayou	51.0	51.0	0	51.0	0	0	0
Maniece Bayou	21.6	21.6	0	21.6	0	0	0
McKinney Bayou	65.6	63.2	1.4	64.6	0	1.0	1.0
Intervening Areas - Ark. and Okla.	79.2	61.6	10.5	72.1	0	7.1	7.1
Intervening Areas - Tex.	74.7	11.1	32.3	43.4	9.8	21.5	31.3
Nantachie Creek	0	0	0	0	0	0	0
Posten Bayou	21.9	17.2	0	17.2	4.7	0	4.7
Red River Backwater Area	92.5	72.5	12.0	84.5	0	8.0	8.0
Red River Main Stem	11.0	11.0	0	11.0	0	0	0
Sulphur River	53.8	0	32.3	32.3	0	21.5	21.5
Grand Total	807.3	572.3	126.7	699.0	24.0	84.3	108.3

A subdivision of the tributary basin acreages presented in table 12, into states and land resource areas, is presented in exhibit 14.

Table 12 data are summarized by state and land resource area in table 12A. The 807,300 acres with a potential for group drainage and flood prevention development are divided as follows: Arkansas - 127,000 acres, Louisiana - 468,200 acres, Oklahoma - 65,700 acres, and Texas - 146,400 acres. The 596,300 acres with a potential for project development are divided as follows: Arkansas - 115,300 acres, Louisiana - 393,700 acres, Oklahoma - 58,300 acres, and Texas - 29,000 acres. The 699,000 acres identified as potential development by 1980 are divided as follows: Arkansas - 115,300 acres, Louisiana - 431,200 acres, Oklahoma - 62,900 acres, and Texas - 89,600 acres. The 108,300 acres identified as long-term potential development are divided as follows: Arkansas - 11,700 acres, Louisiana - 37,000 acres, Oklahoma - 2,800 acres, and Texas - 56,800 acres.

Table 12 data are sumarized by land resource area in table 12B.

FARM DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL

There are large acreages of soils with a drainage and flood problem having a potential for on-farm drainage and flood prevention improvement. All of the feasible acreage, 1,279,500 acres, is sidered to have a potential for on-farm drainage and flood prevention improvement.

No attempt was made to divide the soils with a potential for on-farm drainage and flood prevention improvement into the 1980 and long-term potential acreages. It is expected that development of this on-farm potential will follow the pattern of development of the group potential since the two are interrelated. There will be a lag period, because group drainage and flood prevention improvement is a prerequisite to installation of on-farm drainage and flood prevention improvement.

TABLE 12A - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL - 1980 AND LONG-TERM - BY STATE AND LAND RESOURCE AREA

Red River Basin Study Area

State and Land Resource Area	Total Group Drainage and Flood Prevention Potential	1980 Project	1980 Non-Project	1980 Total	Long-Term Project	Long-Term Non-Project	Long-Term Total
	(acres - thousands)						
Arkansas							
131	127.0	108.3	7.0	115.3	7.0	4.7	11.7
Total	127.0	108.3	7.0	115.3	7.0	4.7	11.7
Louisiana							
131	466.2	386.5	43.5	430.0	7.2	29.0	36.2
134	2.0	0	1.2	1.2	0	0.8	0.8
Total	468.2	386.5	44.7	431.2	7.2	29.8	37.0
Oklahoma							
131	65.7	58.3	4.6	62.9	0	2.8	2.8
Total	65.7	58.3	4.6	62.9	0	2.8	2.8
Texas							
86	49.6	0	29.8	29.8	0	19.8	19.8
131	55.6	19.2	15.9	35.1	9.8	10.7	20.5
133	41.2	0	24.7	24.7	0	16.5	16.5
Total	146.4	19.2	70.4	89.6	9.8	47.0	56.8
Grand Total	807.3	572.3	126.7	699.0	24.0	84.3	108.3

TABLE 12B - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL - 1980 AND LONG-TERM - BY LAND RESOURCE AREA

Red River Basin Study Area

Land Resource Area	Total Group Drainage and Flood Prevention Potential	1980 Project	1980 Non-Project	1980 Total	Long-Term Project	Long-Term Non-Project	Long-Term Total
	(acres - thousands)						
86	49.6	0	29.8	29.8	0	19.8	19.8
131	714.5	572.3	71.0	643.3	24.0	47.2	71.2
133	41.2	0	24.7	24.7	0	16.5	16.5
134	2.0	0	1.2	1.2	0	0.8	0.8
Grand Total	807.3	572.3	126.7	699.0	24.0	84.3	108.3

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Drainage and Flood Problem Area				Soils With No Drainage And Flood Problem				Soils With A Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Barkman Creek												
Texas												
86	0	393	90	483	0	0	0	0	0	393	90	483
131	5,879	5,836	5,865	17,580	1,818	4,261	1,310	7,389	4,061	1,575	4,555	10,191
133	865	519	9,547	10,931	0	0	0	0	865	519	9,547	10,931
Total	6,744	6,748	15,502	28,994	1,818	4,261	1,310	7,389	4,926	2,487	14,192	21,605
Bayou Jean de Jean												
Louisiana												
131	240	610	1,940	2,790	65	100	85	250	175	510	1,855	2,540
133	13	14	14,779	14,806	0	0	0	0	13	14	14,779	14,806
Total	253	624	16,719	17,596	65	100	85	250	185	524	16,634	17,346
Bayou Pierre												
Louisiana												
131	65,000	67,000	48,000	180,000	24,327	12,769	1,301	38,397	40,673	54,231	46,699	141,603
133	1,117	22,816	118,568	142,501	0	0	0	0	1,117	22,816	118,568	142,501
Total	66,117	89,816	166,568	322,501	24,327	12,769	1,301	38,397	41,790	77,047	165,267	284,104
Bayou Rapides												
Louisiana												
131	11,350	18,100	7,850	37,300	3,200	2,000	50	5,250	8,150	16,100	7,800	32,050
133	0	0	1,000	1,000	0	0	0	0	0	0	1,000	1,000
Total	11,350	18,100	8,850	38,300	3,200	2,000	50	5,250	8,150	16,100	8,800	33,050
Bayou Rigolette												
Louisiana												
131	19,300	17,100	20,800	57,200	11,487	1,995	1,522	15,004	7,813	15,105	19,278	42,196
133	0	734	28,326	29,070	0	0	0	0	0	734	28,326	29,060
Total	19,300	17,834	49,126	86,260	11,487	1,995	1,522	15,004	7,813	15,839	47,604	71,256

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin : State and Land Resource Area	Drainage and Flood Problem Area : Cropland	Pasture	Woodland	Total	Soils With No Drainage And Flood Problem : Cropland	Pasture	Woodland	Total	Soils With A Drainage And Flood Problem : Cropland	Pasture	Woodland	Total
	Acres											
Black & Saline Lakes												
Louisiana												
131	3,300	8,900	7,700	19,900	1,985	579	102	2,666	1,315	8,321	7,598	17,234
133	521	7,643	165,026	173,190	0	0	0	0	521	7,643	165,026	173,190
Total	3,821	16,543	172,726	193,090	1,985	579	102	2,666	1,836	15,964	172,624	190,424
Blue River												
Oklahoma												
131	2,028	1,631	1,307	4,966	1,335	1,631	1,307	4,273	693	0	0	693
84 & 84a	341	1,519	341	2,201	0	0	0	0	341	1,519	341	2,201
133	0	839	1,624	2,463	0	0	0	0	0	839	1,624	2,463
85	234	1,030	8,784	10,048	0	0	0	0	234	1,030	8,784	10,048
Total	2,603	5,019	12,056	19,678	1,335	1,631	1,307	4,273	1,268	3,388	10,749	15,405
Boggy Creek												
Oklahoma												
131	8,700	0	8,425	17,125	1,858	0	1,860	3,718	6,842	0	6,565	13,407
112	3,774	8,807	50,325	62,906	0	0	0	0	3,774	8,807	50,325	62,906
84 & 84a	0	0	370	370	0	0	0	0	0	0	370	370
133	1,665	9,972	31,481	43,118	0	0	0	0	1,665	9,972	31,481	43,118
85	0	515	10,960	11,475	0	0	0	0	0	515	10,960	11,475
119	3,976	3,427	5,984	13,387	0	0	0	0	3,976	3,427	5,984	13,387
Total	18,115	22,721	107,545	148,381	1,858	0	1,860	3,718	16,257	22,721	105,685	144,663
Bois d'Arc Creek												
Arkansas												
86	1,661	2,464	2,807	6,932	0	0	0	0	1,661	2,464	2,807	6,932
131	6,000	2,200	11,000	19,200	5,542	2,200	3,440	11,182	458	0	7,560	8,018
133	974	3,035	22,850	26,859	0	0	0	0	974	3,035	22,850	26,859
Total	8,635	7,699	36,657	52,991	5,542	2,200	3,440	11,182	3,093	5,499	33,217	41,809

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin : State and Land Resource Area	Drainage and Flood Problem Area				Soils With No Drainage And Flood Problem				Soils With A Drainage And Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Cane River												
Louisiana												
131	19,295	41,840	55,650	116,785	12,371	2,406	1,867	16,644	6,924	39,434	53,783	100,141
133	386	1,213	56,849	58,448	0	0	0	0	386	1,213	56,849	58,448
Total	19,681	43,053	112,499	175,233	12,371	2,406	1,867	16,644	7,310	40,647	110,632	158,589
Chatlin Lake and Associated Area												
Louisiana												
131	114,500	94,300	253,700	462,500	42,036	19,276	28,543	89,855	72,464	75,024	225,157	372,645
134	8,172	12,112	5,996	26,280	0	0	0	0	8,172	12,112	5,996	26,280
Total	122,672	106,412	259,696	488,780	42,036	19,276	28,543	89,855	80,636	87,136	231,153	398,925
Cypress Creek												
Arkansas												
133	69	941	8,959	9,969	0	0	0	0	69	941	8,959	9,969
Subtotal	69	941	8,959	9,969	0	0	0	0	69	941	8,959	9,969
Louisiana												
131	80,373	22,069	10,226	112,668	30,979	9,794	2,604	43,377	49,394	12,275	7,622	69,291
133	313	15,424	47,957	63,694	0	0	0	0	313	15,424	47,957	63,694
Subtotal	80,686	37,493	58,183	176,362	30,979	9,794	2,604	43,377	49,707	27,699	55,579	132,985
Texas												
133	20,097	64,341	272,547	356,985	0	0	0	0	20,097	64,341	272,547	356,985
Subtotal	20,097	64,341	272,547	356,985	0	0	0	0	20,097	64,341	272,547	356,985
Total	100,852	102,775	339,689	543,316	30,979	9,794	2,604	43,377	69,873	92,981	337,085	499,939
Kiamichi River												
Oklahoma												
131	5,039	1,156	4,530	10,725	0	0	0	0	5,039	1,156	4,530	10,725
133	0	8,866	24,083	32,949	0	0	0	0	0	8,866	24,083	32,949
85	0	879	5,871	6,750	0	0	0	0	0	879	5,871	6,750
119	0	13,993	40,642	54,635	0	0	0	0	0	13,993	40,642	54,635
Total	5,039	24,894	75,126	105,059	0	0	0	0	5,039	24,894	75,126	105,059

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Drainage and Flood Problem Area				Soils With No Drainage and Flood Problem				Soils With A Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Little River												
Arkansas												
86	8,334	5,298	1,763	15,395	0	0	0	0	8,334	5,298	1,763	15,395
131	350	2,200	30,500	33,050	21	59	12	92	329	2,141	30,488	32,958
133	4,064	23,911	185,287	213,262	0	0	0	0	4,064	23,911	185,287	213,262
119	0	854	23,597	24,451	0	0	0	0	0	854	23,597	24,451
Subtotal	12,748	32,263	241,147	286,158	21	59	12	92	12,727	32,204	241,135	286,066
Oklahoma												
86	542	344	114	1,000	0	0	0	0	542	344	114	1,000
133	0	4,130	17,690	21,820	0	0	0	0	0	4,130	17,690	21,820
85	0	0	7,407	7,407	0	0	0	0	0	0	7,407	7,407
119	0	3,243	32,070	35,313	0	0	0	0	0	3,243	32,070	35,313
Subtotal	542	7,717	57,281	65,540	0	0	0	0	542	7,717	57,281	65,540
Total	13,290	39,980	298,428	351,698	21	59	12	92	13,269	39,921	298,416	351,606
Loggy Bayou												
Arkansas												
133	2,992	10,323	299,091	312,406	0	0	0	0	2,992	10,323	299,091	312,406
Subtotal	2,992	10,323	299,091	312,406	0	0	0	0	2,992	10,323	299,091	312,406
Louisiana												
131	42,000	16,900	20,400	79,300	3,981	1,391	538	5,910	38,019	15,509	19,862	73,390
133	383	15,256	197,447	213,086	0	0	0	0	383	15,256	197,447	213,086
Subtotal	42,383	32,156	217,847	292,386	3,981	1,391	538	5,910	38,402	30,765	217,309	286,476
Total	45,375	42,479	516,938	604,792	3,981	1,391	538	5,910	41,394	41,088	516,400	598,882
Maniece Bayou												
Arkansas												
131	15,800	12,600	17,400	45,800	13,408	3,658	4,734	21,800	2,392	8,942	12,666	24,000
133	782	793	7,995	9,570	0	0	0	0	782	793	7,995	9,570
Total	16,582	13,393	25,395	55,370	13,408	3,658	4,734	21,800	3,174	9,735	20,661	33,570

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin : State and Land Resource Area	Drainage and Flood Problem Area				Soils With No Drainage and Flood Problem				Soils With A Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
McKinney Bayou												
Arkansas												
131	52,697	20,967	61,462	135,126	41,460	15,286	3,820	60,566	11,237	5,681	57,642	74,560
133	3,445	3,867	11,298	18,610	0	0	0	0	3,445	3,867	11,298	18,610
Subtotal	56,142	24,834	72,760	153,736	41,460	15,286	3,820	60,566	14,682	9,548	68,940	93,170
Texas												
131	3,996	3,678	3,988	11,662	968	2,503	591	4,062	3,028	1,175	3,397	7,600
133	142	85	1,562	1,789	0	0	0	0	142	85	1,562	1,789
Subtotal	4,138	3,763	5,550	13,451	968	2,503	591	4,062	3,170	1,260	4,959	9,389
Total	60,280	28,597	78,310	167,187	42,428	17,789	4,411	64,628	17,852	10,808	73,899	102,559
Intervening Areas - Arkansas and Oklahoma												
Arkansas												
86	1,976	0	220	2,196	0	0	0	0	1,976	0	220	2,196
131	41,991	14,272	16,248	72,511	31,123	5,763	0	36,886	10,868	8,509	16,248	35,625
133	494	988	12,900	14,382	0	0	0	0	494	988	12,900	14,382
Subtotal	44,461	15,260	29,368	89,089	31,123	5,763	0	36,886	13,338	9,497	29,368	52,203
Oklahoma												
131	50,024	42,219	31,367	123,610	34,886	10,989	8,227	54,102	15,138	31,230	23,140	69,508
133	0	9,187	17,688	26,875	0	0	0	0	0	9,187	17,688	26,875
85	406	1,815	15,467	17,688	0	0	0	0	406	1,815	15,467	17,688
Subtotal	50,430	53,221	64,522	168,173	34,886	10,989	8,227	54,102	15,544	42,232	56,295	114,071
Total	94,891	68,481	93,890	257,262	66,009	16,752	8,227	90,988	28,882	51,729	85,663	166,274
Intervening Areas - Texas												
Texas												
86	58,491	16,214	29,461	104,166	0	0	0	0	58,491	16,214	29,461	104,166
131	54,769	27,909	51,105	133,783	13,909	12,055	5,266	31,230	40,860	15,854	45,839	102,553
133	10,086	7,487	151,812	169,385	0	0	0	0	10,086	7,487	151,812	169,385
Total	123,346	51,610	232,378	407,334	13,909	12,055	5,266	31,230	109,437	39,555	227,112	376,104

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Drainage and Flood Problem Area				Soils With No Drainage and Flood Problem				Soils With A Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Nantachie Creek												
Louisiana												
131	0	0	0	0	0	0	0	0	0	0	0	0
133	0	325	10,055	10,380	0	0	0	0	0	325	10,055	10,380
Total	0	325	10,055	10,380	0	0	0	0	0	325	10,055	10,380
Posten Bayou												
Arkansas	25,714	12,760	6,616	45,090	13,223	9,279	0	22,502	12,491	3,481	6,616	22,588
133	190	797	5,499	5,486	0	0	0	0	190	797	5,499	6,486
Subtotal	25,904	13,557	12,115	51,576	13,223	9,279	0	22,502	12,681	4,278	12,115	29,074
Louisiana												
131	8,056	3,635	2,709	14,400	638	1,494	0	2,132	7,418	2,141	2,709	12,268
133	0	203	1,138	1,341	0	0	0	0	0	203	1,138	1,341
Subtotal	8,056	3,838	3,847	15,741	638	1,494	0	2,132	7,418	2,344	3,847	13,609
Total	33,960	17,395	15,962	67,317	13,861	10,773	0	24,634	20,099	6,622	15,962	42,683
Red River Backwater Area												
Louisiana												
131	33,317	26,400	348,983	408,700	17,638	6,092	0	23,730	15,679	20,308	348,983	384,970
133	0	16	1,170	1,186	0	0	0	0	0	16	1,170	1,186
134	2,080	3,253	13,114	18,447	0	0	0	0	2,080	3,253	13,114	18,447
Total	35,397	29,669	363,267	428,333	17,638	6,092	0	23,730	17,759	23,577	363,267	404,603
Red River Main Stem												
Louisiana												
131	22,300	65,600	68,600	156,500	14,980	43,878	25,090	83,948	7,320	21,722	43,510	72,552
133	129	2,649	27,623	30,401	0	0	0	0	129	2,649	27,623	30,401
134	1,632	2,072	997	4,701	0	0	0	0	1,632	2,072	997	4,701
Total	24,061	70,321	97,220	191,602	14,980	43,878	25,090	83,948	9,081	26,443	72,130	107,654

EXHIBIT 1 - DRAINAGE AND FLOOD PROBLEM INVENTORY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Drainage and Flood Problem Area				Soils With No Drainage and Flood Problem				Soils With A Drainage and Flood Problem			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Sulphur River												
Arkansas												
131	0	0	17,401	17,401	0	0	0	0	0	0	17,401	17,401
133	112	1,536	14,661	16,309	0	0	0	0	112	1,536	14,661	16,309
Subtotal	112	1,536	32,082	33,710	0	0	0	0	112	1,536	32,062	33,710
Texas												
86	110,175	80,419	152,351	342,945	0	0	0	0	110,175	80,419	152,351	342,945
133	26,430	49,065	193,785	269,280	0	0	0	0	26,430	49,065	193,785	269,280
Subtotal	136,605	129,484	346,136	612,225	0	0	0	0	136,605	129,484	346,136	612,225
Total	136,717	131,020	378,198	645,935	0	0	0	0	136,717	131,020	378,198	645,935
Grand Total	969,081	955,508	3,482,800	5,407,389	323,238	169,458	92,269	584,965	645,843	786,050	3,390,531	4,822,424

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

Tributary Basin: State and Land Resource Area	Soils With a Drainage and Flood Problem				Soils With Adequate Drainage and Flood Prevention Improvement				Soils With Inadequate Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Barkman Creek												
Texas												
86	-	393	90	483	-	-	-	-	-	393	90	483
131	4,061	1,575	4,555	10,191	1,300	700	-	2,000	2,761	875	4,555	8,191
133	865	519	9,547	10,931	-	-	-	-	865	519	9,547	10,931
Total	4,926	2,487	14,192	21,605	1,300	700	-	2,000	3,626	1,787	14,192	19,605
Bayou Jean de Jean												
Louisiana												
131	175	510	1,855	2,540	-	-	-	-	175	510	1,855	2,540
133	13	14	14,779	14,806	-	-	-	-	13	14	14,779	14,806
Total	185	524	16,634	17,346	-	-	-	-	185	524	16,634	17,346
Bayou Pierre												
Louisiana												
131	40,673	54,231	46,699	141,603	24,100	24,100	-	48,200	16,573	30,131	46,699	93,403
133	1,117	22,816	118,568	142,501	-	-	-	-	1,117	22,816	118,568	142,501
Total	41,790	77,047	165,267	284,104	24,100	24,100	-	48,200	17,690	52,947	165,267	235,904
Bayou Rapides												
Louisiana												
131	8,150	16,100	7,800	32,050	3,720	5,580	-	9,300	4,430	10,520	7,800	22,750
133	-	-	1,000	1,000	-	-	-	-	-	-	1,000	1,000
Total	8,150	16,100	8,800	33,050	3,720	5,580	-	9,300	4,430	10,520	8,800	23,750
Bayou Rigolette												
Louisiana												
131	7,813	15,105	19,278	42,196	5,150	9,550	-	14,700	2,663	5,555	19,278	27,496
133	-	734	28,326	29,060	-	40	-	40	-	694	28,326	29,020
Total	7,813	15,839	47,604	71,256	5,150	9,590	-	14,740	2,663	6,249	47,604	56,516

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin: State and Land Resource Area	Soils With a Drainage and Flood Problem: Cropland	Pasture	Woodland	Total	Soils With Adequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total	Soils With Inadequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total
	Acres											
Black & Saline Lakes												
Louisiana												
131	1,315	8,321	7,598	17,234	600	1,800	-	2,400	715	5,521	7,598	14,834
133	521	7,643	165,026	173,190	-	-	-	-	521	7,643	165,026	173,190
Total	1,836	15,964	172,624	190,424	600	1,800	-	2,400	1,236	14,164	172,624	188,024
Blue River												
Oklahoma												
131	693	-	-	693	200	-	-	200	493	-	-	493
84 & 84a	341	1,519	341	2,201	-	-	-	-	341	1,519	341	2,201
133	-	839	1,624	2,463	-	800	-	800	-	39	1,624	1,663
85	234	1,030	8,784	10,048	150	350	-	500	84	680	8,784	9,548
Total	1,268	3,388	10,749	15,405	350	1,150	-	1,500	918	2,238	10,749	13,905
Boggy Creek												
Oklahoma												
131	6,842	-	6,565	13,407	100	-	-	100	6,742	-	6,565	13,307
112	3,774	8,807	50,325	62,906	3,774	8,807	3,094	15,675	-	-	47,231	47,231
84 & 84a	-	-	370	370	-	-	-	-	-	-	370	370
133	1,665	9,972	31,481	43,118	1,490	8,450	-	9,940	175	1,522	31,481	33,178
85	-	515	10,960	11,475	-	515	285	800	-	-	10,675	10,675
119	3,976	3,427	5,984	13,387	1,470	980	-	2,450	2,506	2,447	5,984	10,937
Total	16,257	22,721	105,685	144,663	6,834	18,752	3,379	28,965	9,423	3,969	102,306	115,698
Bois d'Arc Creek												
Arkansas												
86	1,661	2,464	2,807	6,932	1,100	900	-	2,000	561	1,564	2,807	4,932
131	458	-	7,560	8,018	458	-	1,542	2,000	-	-	6,018	6,018
133	974	3,035	22,850	26,859	750	750	-	1,500	224	2,285	22,850	25,359
Total	3,093	5,499	33,217	41,809	2,308	1,650	1,542	5,500	785	3,849	31,675	36,309

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin: State and Land Resource Area	Soils With a Drainage and Flood Problem: Cropland	Pasture	Woodland	Total	Soils With Adequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total	Soils With Inadequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total
	Acres											
Cane River												
Louisiana												
131	6,924	39,484	53,783	100,141	6,600	30,400	-	37,000	324	9,034	53,783	63,141
133	386	1,213	56,849	58,448	50	-	-	50	336	1,213	56,849	58,398
Total	7,310	40,647	110,632	158,589	6,650	30,400	-	37,050	660	10,247	110,632	121,539
Chatlin Lake and Associated Area												
Louisiana												
131	72,464	75,024	225,157	372,645	60,000	49,100	-	109,100	12,464	25,924	225,157	263,545
134	8,172	12,112	5,996	26,280	4,620	3,080	-	7,700	3,552	9,032	5,996	18,580
Total	80,636	87,136	231,153	398,925	64,620	52,180	-	116,800	16,016	34,956	231,153	282,125
Cypress Creek												
Arkansas												
133	69	941	8,959	9,969	-	-	-	-	69	941	8,959	9,969
Subtotal	69	941	8,959	9,969	-	-	-	-	69	941	8,959	9,969
Louisiana												
131	49,394	12,275	7,622	69,291	33,320	5,880	-	39,200	16,074	6,395	7,622	30,091
133	313	15,424	47,957	63,694	-	-	-	-	313	15,424	47,957	63,694
Subtotal	49,707	27,699	55,579	132,985	33,320	5,880	-	39,200	16,387	21,819	55,579	93,785
Texas												
133	20,097	64,341	272,547	356,985	300	80	-	380	19,797	64,261	272,547	356,605
Subtotal	20,097	64,341	272,547	356,985	300	80	-	380	19,797	64,261	272,547	356,605
Total	69,873	92,981	337,085	499,939	33,620	5,960	-	39,580	36,253	87,021	337,085	460,359
Kiamichi River												
Oklahoma												
131	5,039	1,156	4,530	10,725	2,230	250	-	2,480	2,809	906	4,530	8,245
133	-	8,866	24,083	32,949	-	-	-	-	-	8,866	24,083	32,949
85	-	879	5,871	6,750	-	-	-	-	-	879	5,871	6,750
119	-	13,993	40,642	54,635	-	120	-	120	-	13,873	40,642	54,515
Total	5,039	24,894	75,126	105,059	2,230	370	-	2,600	2,809	24,524	75,126	102,459

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin: State and Land Resource Area	Soils With a Drainage and Flood Problem: Cropland	Pasture	Woodland	Total	Soils With Adequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total	Soils With Inadequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total
	Acres											
Little River												
Arkansas												
86	8,334	5,298	1,763	15,395	5,025	1,675	-	6,700	3,309	3,623	1,763	8,695
131	329	2,141	30,488	32,958	100	50	-	150	229	2,091	30,488	32,808
133	4,064	23,911	185,287	213,262	500	2,290	-	2,790	3,564	21,621	185,287	210,472
119	-	854	23,597	24,451	-	50	-	50	-	804	23,597	24,401
Subtotal	12,727	32,204	241,135	286,066	5,625	4,065	-	9,690	7,102	28,139	241,135	276,376
Oklahoma												
86	542	344	144	1,000	-	-	-	-	542	344	114	1,000
133	-	4,130	17,690	21,820	-	-	-	-	-	4,130	17,690	21,820
85	-	-	7,407	7,407	-	-	-	-	-	-	7,407	7,407
119	-	3,243	32,070	35,313	-	-	-	-	-	3,243	32,070	35,313
Subtotal	542	7,717	57,281	65,540	-	-	-	-	542	7,717	57,281	65,540
Total	13,269	39,921	298,416	351,606	5,625	4,065	-	9,690	7,644	35,856	298,416	341,916
Loggy Bayou												
Arkansas												
133	2,992	10,323	299,091	312,406	600	1,200	-	1,800	2,392	9,123	299,091	310,606
Subtotal	2,992	10,323	299,091	312,406	600	1,200	-	1,800	2,392	9,123	299,091	310,606
Louisiana												
131	38,091	15,509	19,862	73,309	10,150	4,350	-	14,500	27,869	11,159	19,862	58,890
133	383	15,256	197,447	213,086	-	-	-	-	383	15,256	197,447	213,086
Subtotal	38,402	30,765	217,309	286,476	10,150	4,350	-	14,500	28,252	26,415	217,309	271,976
Total	41,394	41,088	516,400	598,882	10,750	5,550	-	16,300	30,644	35,538	516,400	582,582
Maniece Bayou												
Arkansas												
131	2,392	8,942	12,666	24,000	500	1,500	-	2,000	1,892	7,442	12,666	22,000
133	782	793	7,995	9,570	-	-	-	-	782	793	7,995	9,570
Total	3,174	9,735	20,661	33,570	500	1,500	-	2,000	2,674	8,235	20,661	31,570

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Soils With a Drainage and Flood Problem				Soils With Adequate Drainage and Flood Prevention Improvement				Soils With Inadequate Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
McKinney Bayou												
Arkansas												
131	11,237	5,681	57,642	74,560	6,250	3,750	2,500	12,500	4,987	1,931	55,142	62,060
133	3,445	3,867	11,298	18,610	585	315	-	900	2,860	3,552	11,298	17,710
Subtotal	14,682	9,548	68,940	93,170	6,835	4,065	2,500	13,400	7,847	5,483	66,440	79,770
Texas												
131	3,028	1,175	3,397	7,600	1,200	800	-	2,000	1,828	375	3,397	5,600
133	142	85	1,562	1,789	-	-	-	-	142	85	1,562	1,789
Subtotal	3,170	1,260	4,959	9,389	1,200	800	-	2,000	1,970	460	4,959	7,389
Total	17,852	10,808	73,899	102,559	8,035	4,865	2,500	15,400	9,817	5,943	71,399	87,159
Intervening Areas - Arkansas and Oklahoma												
Arkansas												
86	1,976	-	220	2,196	300	-	-	300	1,676	-	220	1,896
131	10,868	8,509	16,248	35,625	4,290	2,310	-	6,600	6,578	6,199	16,248	29,025
133	494	988	12,900	14,382	494	988	268	1,750	-	-	12,632	12,632
Subtotal	13,338	9,497	29,368	52,203	5,084	3,298	268	8,650	8,254	6,199	29,100	43,553
Oklahoma												
131	15,138	31,230	23,140	69,508	1,800	1,800	-	3,600	13,338	29,430	23,140	65,908
133	-	9,187	17,688	26,875	-	2,150	-	2,150	-	7,037	17,688	24,725
85	406	1,815	15,467	17,688	300	900	-	1,200	106	915	15,467	16,488
Subtotal	15,544	43,232	56,295	114,071	2,100	4,850	-	6,950	13,444	37,382	56,295	107,121
Total	28,882	51,729	85,663	166,274	7,184	8,148	268	15,600	21,698	43,581	85,395	150,674
Intervening Areas - Texas												
Texas												
86	58,491	16,214	29,461	104,166	1,600	400	-	2,000	56,891	15,814	29,461	102,166
131	40,860	15,854	45,839	102,553	12,525	4,175	-	16,700	28,335	11,679	45,839	85,853
133	10,086	7,487	151,812	169,385	-	-	-	-	10,086	7,487	151,812	169,385
Total	109,437	39,555	227,112	376,104	14,125	4,575	-	18,700	95,312	34,980	227,112	357,404

AD-A036 751 RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA F/G 8/6
COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSA--ETC(U)
JUN 68

UNCLASSIFIED NL

3 OF 3
AD
A036751

END
DATE
FILMED
4-77

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Soils With a Drainage and Flood Problem				Soils With Adequate Drainage and Flood Prevention Improvement				Soils With Inadequate Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Nantachie Creek												
Louisiana												
131	-	-	-	-	-	-	-	-	-	-	-	-
133	-	325	10,055	10,380	-	-	-	-	-	325	10,055	10,380
Total	-	325	10,055	10,380	-	-	-	-	-	325	10,055	10,380
Posten Bayou												
Arkansas												
131	12,491	3,481	6,616	22,588	4,000	1,000	-	5,000	8,491	2,481	6,616	17,588
133	190	797	5,499	6,486	-	-	-	-	190	797	5,499	6,486
Subtotal	12,681	4,278	12,115	29,074	4,000	1,000	-	5,000	8,681	3,278	12,115	24,074
Louisiana												
131	7,418	2,141	2,709	12,268	5,500	1,500	-	7,000	1,918	641	2,709	5,268
133	-	203	1,138	1,341	-	-	-	-	-	203	1,138	1,341
Subtotal	7,418	2,344	3,847	13,609	5,500	1,500	-	7,000	1,918	844	3,847	6,609
Total	20,099	6,622	15,962	42,683	9,500	2,500	-	12,000	10,599	4,122	15,962	30,683
Red River Backwater Area												
Louisiana												
131	15,679	20,308	348,983	384,970	6,460	3,480	-	9,940	9,219	16,828	348,983	375,030
133	-	16	1,170	1,186	-	-	-	-	-	16	1,170	1,186
134	2,080	3,253	13,114	18,447	450	450	-	900	1,630	2,803	13,114	17,547
Total	17,759	23,577	363,267	404,603	6,910	3,930	-	10,840	10,849	19,647	363,267	393,763
Red River Main Stem												
Louisiana												
131	7,320	21,722	43,510	72,552	3,025	5,615	-	8,640	4,295	16,107	43,510	63,912
133	129	2,649	27,623	30,401	-	-	-	-	129	2,649	27,623	30,401
134	1,632	2,072	997	4,701	300	300	-	600	1,332	1,772	997	4,101
Total	9,081	26,443	72,130	107,654	3,325	5,915	-	9,240	5,756	20,528	72,130	98,414

EXHIBIT 2 - ANALYSIS OF DRAINAGE AND FLOOD PROBLEM BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin: State and Land Resource Area	Soils With a Drainage and Flood Problem: Cropland	Pasture	Woodland	Total	Soils with Adequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total	Soils With Inadequate Drainage and Flood Prevention Improvement: Cropland	Pasture	Woodland	Total
	Acres											
Sulphur River												
Arkansas												
131	-	-	17,401	17,401	-	-	-	-	-	-	17,401	17,401
133	112	1,536	14,661	16,309	-	-	-	-	112	1,536	14,661	16,309
Subtotal	112	1,536	32,062	33,710	-	-	-	-	112	1,536	32,062	33,710
Texas												
86	110,175	80,419	152,351	342,945	5,200	600	-	5,800	104,975	79,819	152,351	337,145
133	26,430	49,065	193,785	269,280	-	-	-	-	26,430	49,065	193,785	269,280
Subtotal	136,605	129,484	346,136	612,225	5,200	600	-	5,800	131,405	128,884	346,136	606,425
Total	136,717	131,020	378,198	645,935	5,200	600	-	5,800	131,517	130,420	378,198	640,135
Grand Total	645,843	786,050	3,390,531	4,822,424	222,636	193,880	7,689	424,205	423,207	592,170	3,382,842	4,398,219

Exhibit 3A. - Corn: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, bottomlands soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Corn	Bu.	40	1.16	46.40
Variable inputs:				
Seed	Lb.	18	.205	3.69
Fertilizer, N.P.K.	Lb.	20-20-20	.12-.10-.05	5.40
Side dress	Lb.	60 N	.12	7.20
Power	Hr.	3.55	1.28	4.54
Other machinery	Ac.	1.0	2.55	2.55
Total preharvest costs				23.38
Custom harvest	Ac.	1	5.18	5.18
Custom shelling	Bu.	40	.06	2.40
Haul	Bu.	40	.06	2.40
Total harvesting costs				9.98
Interest on operating capital	Dols.	14.75	.06	.88
Total specified costs				34.24
Returns above variable inputs				12.16
Hourly labor	Hr.	4.34	1.25	5.42
Returns above variable inputs and labor				6.74

Exhibit 3B. - Corn: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Corn	Bu.	58	1.16	67.28
Variable inputs:				
Seed	Lb.	16	.205	3.28
Fertilizer, N.P.K.	Lb.	40-40-40	.12-.10-.05	10.80
Side dress	Lb.	50 N	.12	6.00
Power	Hr.	3.27	1.28	4.19
Other machinery	Ac.	1.0	2.38	2.38
Total preharvest cost				26.65
Combination picker-sheller	Hr.	0.5	8.88	4.44
Haul	Bu.	58	.06	3.48
Total harvesting costs				7.92
Interest on operating capital	Dol.	17.95	.06	1.08
Total specified costs				35.65
Returns above variable inputs				31.63
Hourly labor	Hr.	4.49	1.25	5.61
Returns above variable inputs and labor				26.02

Exhibit 3C. - Corn: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Corn	Bu.	30	1.16	34.80
Variable inputs:				
Seed	Lb.	20	.205	4.10
Fertilizer, N.P.K.	Lb.	6-12-12	.12-.10-.05	2.52
Side dress	Lb.	50 N	.12	6.00
Power	Hr.	3.55	1.28	4.54
Other machinery	Ac.	1.0	2.55	2.55
Total preharvest costs				19.71
Custom harvest	Ac.	1.0	5.18	5.18
Custom shelling	Bu.	30	.06	1.80
Haul	Bu.	30	.06	1.80
Total harvesting costs				8.78
Interest on operating capital	Dol.	12.42	.06	.74
Total specified costs				29.23
Returns above variable inputs				5.57
Hourly labor				5.42
Returns above variable inputs and labor				0.15

Exhibit 3D. - Corn: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Corn	Bu.	43	1.16	49.88
Variable inputs:				
Seed	Lb.	18	.205	3.69
Fertilizer, N.P.K.	Lb.	40-40-40	.12-.10-.05	10.80
Side dress	Lb.	50 N	.12	6.00
Power	Hr.	3.27	1.28	4.19
Other machinery	Ac.	1.0	2.38	2.38
Total preharvest costs				27.06
Combination picker-sheller	Hr.	0.5	8.88	4.44
Haul	Bu.	43	.06	2.58
Total harvesting costs				7.02
Interest on operating capital	Dol.	18.13	.06	1.09
Total specified costs				35.17
Returns above variable inputs				14.71
Hourly labor				5.61
Returns above variable inputs				9.10

Exhibit 4A. - Cotton: Estimated annual "adjusted normalized" costs and returns per acre without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Lint	Lb.	340	.24	81.60
Seed	Lb.	592	.024	14.21
Total				95.81
Variable inputs:				
Seed	Lb.	70	.09	6.30
Fertilizer, N.P.K.	Lb.	20-20-20	.12-.10-.05	5.40
Power	Hr.	4.60	1.28	5.89
Other machinery	Ac.	1	4.75	4.75
Herbicide	Ac.	.5	3.20	1.60
Insecticide and application	Ac.	1	10.75	10.75
Hired hoeing	Time over	1.5	4.55	6.82
Total preharvest cost				41.51
Defoliate and application	Ac.	.4	3.70	1.48
Mechanical pick	Cwt.s.c.	9.8	3.10	30.38
Haul, gin, wrap	Cwt.s.c.	9.8	1.11	10.88
Total harvesting cost				42.74
Annual interest on capital	Dol.	27.00	.06	1.62
Total specified costs				85.87
Returns above variable inputs				9.94
Hourly labor				7.15
Returns above variable inputs and labor				2.79

Exhibit 4B. - Cotton: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Lint	Lb.	575	.24	138.00
Seed	Lb.	1001	.024	24.02
Total				162.02
Variable inputs:				
Seed	Lb.	65	.09	5.85
Fertilizer, N.P.K.	Lb.	28-28-28	.12-.10-.05	7.56
Power	Hr.	4.14	1.28	5.30
Other machinery	Ac.	1	5.54	5.54
Herbicide	Ac.	1	3.20	3.20
Insecticide and application	Ac.	1	14.05	14.05
Hired hoeing	Time over	1.25	4.55	5.69
Total preharvest costs				47.19
Defoliate and application	Ac.	1	3.70	3.70
Mechanical pick	Cwt.s.c.	16.5	3.10	51.15
Haul, gin, wrap	Cwt.s.c.	16.5	1.11	18.32
Total harvesting costs				73.17
Annual interest on capital	Dol.	31.01	.06	1.86
Total specified costs				122.22
Returns above variable inputs				39.80
Hourly labor				7.00
Returns above variable inputs and labor				32.80

Exhibit 4C. - Cotton: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Lint	Lb.	200	.24	48.00
Seed	Lb.	348	.024	8.35
Total				56.35
Variable inputs:				
Seed	Lb.	38	.09	3.42
Fertilizer, N.P.K.	Lb.	50-0-0	.12-.10-.05	6.00
Power	Hr.	4.6	1.28	5.89
Other machinery	Ac.	1.0	4.75	4.75
Herbicide	Ac.	.5	3.20	1.60
Insecticide and application	Ac.	1.5	10.75	5.38
Hired hoeing	Times over	1.0	4.55	4.55
Total preharvest costs				31.59
Defoliate and application	Ac.	.4	3.70	1.48
Mechanical pick	Cwt.s.c.	5.7	3.10	17.67
Haul, gin, wrap	Cwt.s.c.	5.7	1.11	6.33
Total harvesting costs				25.48
Annual interest on capital	Dol.	22.11	.06	1.33
Total specified costs				58.40
Returns above variable inputs				-2.05
Hourly labor				7.15
Returns above variable inputs and labor				-9.20

Exhibit 4D. - Cotton: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Lint	Lb.	300	.24	72.00
Seed	Lb.	522	.024	12.53
Total				84.53
Variable inputs:				
Seed	Lb.	35	.09	3.15
Fertilizer, N.P.K.	Lb.	60-0-0	.12-.10-.05	7.20
Power	Hr.	4.14	1.28	5.30
Other machinery	Ac.	1	5.54	5.54
Herbicide	Ac.	1	3.20	3.20
Insecticide & application	Ac.	1	14.05	14.05
Hired hoeing	Times over	1.25	4.55	5.69
Total preharvest costs				44.13
Defoliate & application	Ac.	1	3.70	3.70
Mechanical pick	Cwt. s.c.	8.6	3.10	26.65
Haul, gin, wrap	Cwt. s.c.	8.6	1.11	9.55
Total harvesting costs				39.91
Annual interest on capital	Dol.	30.89	.06	1.85
Total specified costs				85.89
Returns above variable inputs				- 1.36
Hourly labor				7.00
Returns above variable inputs & labor				- 8.36

Exhibit 5A. - Soybeans: Estimated annual "adjusted normalized" costs and returns per acre without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Soybeans	Bu.	23	2.32	53.36
Variable inputs:				
Seed	Bu.	1.3	4.60	5.98
Fertilizer, N.P.K.	Lb.	5-20-20	.12-.10-.05	3.60
Power	Hr.	1.56	1.28	2.00
Other machinery	Ac.	1.0	1.44	1.44
Total preharvest costs				13.02
Combine	Hr.	.5	6.84	3.42
Haul	Bu.	23	.09	2.07
Total harvesting costs				5.49
Annual interest on capital	Dol.	7.81	.06	.47
Total specified costs				18.98
Returns above variable inputs				34.38
Hourly labor				2.67
Returns above variable inputs and labor				31.71

Exhibit 5B. - Soybeans: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Soybeans	Bu.	34	2.32	78.88
Variable inputs:				
Seed	Bu.	1.2	4.60	5.52
Fertilizer, N.P.K.	Lb.	0-20-30	.12-.10-.05	3.50
Chemicals (Toxaphene)	Lb.	5	.08	.40
Power	Hr.	1.55	1.28	1.98
Other machinery	Ac.	1.0	1.40	1.40
Total preharvest costs				12.80
Combine	Hr.	0.5	6.84	3.42
Haul	Bu.	34	.09	3.06
Total harvesting costs				6.48
Annual interest on capital	Dol.	7.68	.06	.46
Total specified costs				19.74
Returns above variable inputs				59.14
Hourly labor				3.85
Returns above variable inputs and labor				55.29

Exhibit 5A. - Soybeans: Estimated annual "adjusted normalized" costs and returns per acre without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Soybeans	Bu.	23	2.32	53.36
Variable inputs:				
Seed	Bu.	1.3	4.60	5.98
Fertilizer, N.P.K.	Lb.	5-20-20	.12-.10-.05	3.60
Power	Hr.	1.56	1.28	2.00
Other machinery	Ac.	1.0	1.44	1.44
Total preharvest costs				13.02
Combine	Hr.	.5	6.84	3.42
Haul	Bu.	23	.09	2.07
Total harvesting costs				5.49
Annual interest on capital	Dol.	7.81	.06	.47
Total specified costs				18.98
Returns above variable inputs				34.38
Hourly labor				2.67
Returns above variable inputs and labor				31.71

Exhibit 6A. - Grain Sorghum: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grain sorghum	Bu.	35.0	1.04	36.40
Variable inputs:				
Seed	Lb.	12.0	.129	1.55
Fertilizer, N.P.K.	Lb.	45-0-0	.12-.10-.05	5.40
Weedspray (custom)	Ac.	1.0	2.00	2.00
Power	Hr.	3.27	1.28	4.19
Other machinery	Ac.	1.0	2.73	2.73
Total preharvest costs				15.87
Combine	Hr.	0.5	6.84	3.42
Haul	Bu.	35.0	.06	2.10
Total harvesting costs				5.52
Annual interest on capital	Dol.	11.10	.06	.67
Total specified costs				22.06
Returns above variable inputs				14.34
Hourly labor				3.20
Returns above variable inputs and labor				11.14

Exhibit 6B. - Grain Sorghum: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grain sorghum	Bu.	53.0	1.04	55.12
Variable inputs:				
Seed	Lb.	11.0	.129	1.42
Fertilizer, N.P.K.	Lb.	25-50-25	.12-.10-.05	9.25
Side dress, N	Lb.	32.0	.12	3.84
Insecticide (50% DDT)	Lb.	2.0	.65	1.30
Power	Hr.	3.25	1.28	4.16
Other machinery	Ac.	1.0	2.73	2.73
Total preharvest costs				22.70
Combine	Hr.	0.5	6.84	3.42
Haul	Bu.	53.0	.06	3.18
Total harvesting costs				6.60
Annual interest on capital	Dol.	15.89	.06	.95
Total specified costs				30.25
Returns above variable inputs				24.87
Hourly labor				3.35
Returns above variable inputs and labor				21.52

Exhibit 6C. - Grain Sorghum: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grain sorghum	Bu.	30.0	1.04	31.20
Variable inputs:				
Seed	Lb.	13.0	.129	1.68
Fertilizer, N.P.K.	Lb.	40-0-0	.12-.10-.05	4.80
Weedspray (custom)	Ac.	1.0	2.00	2.00
Power	Hr.	3.27	1.28	4.19
Other machinery	Ac.	1.0	2.73	2.73
Total preharvest costs				15.40
Combine	Hr.	0.5	6.84	3.42
Haul	Bu.	30.0	.06	1.80
Total harvesting costs				5.22
Annual interest on capital	Dol.	10.78	.06	.65
Total specific costs				21.27
Returns above variable inputs				9.93
Hourly labor				2.97
Returns above variable inputs and labor				6.96

Exhibit 6D. - Grain Sorghum: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grain sorghum	Bu.	44.0	1.04	45.76
Variable inputs:				
Seed	Lb.	12.0	.129	1.55
Fertilizer, N.P.K.	Lb.	25-50-25	.12-.10-.05	9.25
Weedspray (custom)	Ac.	1.0	2.00	2.00
Power	Hr.	3.25	1.28	4.16
Other machinery	Ac.	1.0	2.73	2.73
Total preharvest costs				19.69
Combine	Hr.	0.5	6.84	3.42
Haul	Bu.	44.0	.06	2.64
Total harvesting costs				6.06
Annual interest on capital	Dol.	13.78	.06	.83
Total specified costs				26.58
Returns above variable inputs				19.18
Hourly labor				3.15
Returns above variable inputs and labor				16.03

Exhibit 7A. - Oats: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Corn	Bu.	30	.68	20.40
Variable inputs:				
Seed	Bu.	3.0	1.59	4.77
Fertilizer, N.P.K.	Lb.	48-0-0	.12-.10-.05	5.76
Insecticide (Toxaphene)	Lb.	12.0	.078	.94
Insecticide application	Ac.	1.0	.76	.76
Power	Hr.	1.91	2.00	3.82
Equipment operation	Ac.	1.0	4.84	4.84
Total preharvest costs				20.89
Combine	Hr.	0.5	6.35	3.18
Hauling	Bu.	30	.06	1.80
Total harvesting costs				4.98
Interest on operating capital	Dol.	14.60	.06	.88
Total specified costs				26.75
Returns above variable inputs				-6.35
Hourly labor				1.82
Returns above variable inputs and labor				-8.17

Exhibit 7B.- Oats: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Oats	Bu.	53	.68	36.04
Variable inputs:				
Seed (for grain only)	Bu.	2.5	1.59	3.98
Fertilizer, N.P.K.	Lb.	10-20-10	.12-.10-.05	3.70
Side dress	Lb.	32 N	.12	3.84
Insecticide and application	Ac.	1.0	1.70	1.70
Tractor operation	Hr.	2.13	2.00	4.26
Equipment operation	Ac.	1.0	1.54	1.54
Total preharvest costs				19.02
Combine	Hr.	0.5	6.14	3.07
Hauling	Bu.	53	0.06	3.18
Total harvesting costs				6.25
Interest on operating capital	Dol.	12.24	0.06	.73
Total specified costs				26.00
Returns above variable inputs				10.04
Hourly labor				2.02
Returns above variable inputs and labor				8.02

Exhibit 7C. - Oats: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Oats	Bu.	30.0	.68	20.40
Variable inputs:				
Seed	Bu.	3.0	1.59	4.77
Fertilizer, N.P.K.	Lb.	10-20-10	.12-.10-.05	3.70
Insecticide and application	Ac.	1.0	1.70	1.70
Power	Hr.	1.91	2.00	3.82
Other machinery	Ac.	1.0	4.50	4.50
Total preharvest costs				18.49
Combine operations	Hr.	0.5	6.14	3.07
Haul	Bu.	30.0	.06	1.80
Total harvesting costs				4.87
Interest on operating capital	Dol.	12.94	.06	.78
Total specified costs				24.14
Returns above variable inputs				-3.74
Hourly labor				1.82
Returns above variable inputs and labor				-5.56

Exhibit 7D. - Oats: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Oats	Bu.	37.0	.68	25.16
Variable inputs:				
Seed (for grain only)	Bu.	2.5	1.59	3.98
Fertilizer, N.P.K.	Lb.	10-20-10	.12-.10-.05	3.70
Side dress	Lb.	30 N	.12	3.60
Power	Hr.	2.13	2.00	4.26
Other machinery	Ac.	1.0	1.54	1.54
Total preharvest costs				17.08
Combine operation	Hr.	0.5	6.14	3.07
Haul	Bu.	37.0	.06	2.22
Total harvesting costs				5.29
Interest on operating capital	Dol.	10.88	.06	.65
Total specified costs				23.02
Returns above variable inputs				2.14
Hourly labor				2.02
Returns above variable inputs and labor				0.12

Exhibit 8A. - Alfalfa: Estimated "adjusted normalized" costs per acre for establishing crop, without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Seed	Lb.	20	.51	10.20
Fertilizer, N.P.K.	Lb.	7 1/2-40-40	.12-.10-.05	6.90
Power	Hr.	1.92	1.28	2.46
Other machinery	Hr.	1.75	.44	.77
Hourly labor	Hr.	2.10	1.25	2.62
Total variable inputs				22.95

Exhibit 8B. - Alfalfa: Estimated "adjusted normalized" costs per acre for establishing crop, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Seed	Lb.	20	.51	10.20
Fertilizer, N.P.K.	Lb.	5-40-40	.12-.10-.05	6.60
Power	Hr.	1.92	1.28	2.46
Other machinery	Hr.	1.75	.44	.77
Hourly labor	Hr.	2.10	1.25	2.62
Total variable inputs				22.65

Exhibit 8C. - Alfalfa: Estimated annual "adjusted normalized" costs per acre for establishing crop, without drainage and flood prevention improvement, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Seed	Lb.	25	.51	12.75
Fertilizer, N.P.K.	Lb.	20-60-60	.12-.10-.05	11.40
Lime	Ac.	1	6.00	6.00
Power	Hr.	3	1.28	3.84
Other machinery	Hr.	3	.44	1.32
Hourly labor	Hr.	4	1.25	5.00
Total variable inputs				40.31

Exhibit 8D. - Alfalfa: Estimated annual "adjusted normalized" costs per acre for establishing crop, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Seed	Lb.	20	.51	10.20
Fertilizer, N.P.K.	Lb.	16-60-60	.12-.10-.05	10.92
Lime	Ac.	1	6.00	6.00
Power	Hr.	5	1.28	6.40
Other machinery	Hr.	5	.44	2.20
Hourly labor	Hr.	6	1.25	7.50
Total variable inputs				43.22

Exhibit 9A. - Alfalfa: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	2.3	29.71	68.33
Variable inputs:				
Fertilizer, N.P.K.	Lb.	0-40-40	.12-.10-.05	6.00
Insecticide (Parathion custom)	Application	2	1.75	3.50
Power	Hr.	.38	1.28	.49
Other machinery	Hr.	.35	.81	.28
Preharvest costs				10.27
Mow, rake, bale	Bale	69	.21	14.49
Haul	Bale	69	.09	6.21
Harvesting costs				20.70
Annual interest on capital	Dol.	5.51	.06	.33
Annual charge for establishing (assume 4-year stand)				5.74
Annual interest on establishing costs	Dol.			.69
Total specified costs				37.73
Returns above variable inputs				30.60
Hourly labor				.53
Returns above variable inputs and labor				30.07

Exhibit 9B. - Alfalfa: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	3.5	29.71	103.98
Variable inputs:				
Fertilizer, N.P.K.	Lb.	0-40-40	.12-.10-.05	6.00
Insecticide (Parathion custom)	Application	2	1.75	3.50
Power	Hr.	.38	1.28	.49
Other machinery	Hr.	.35	.81	.28
Total preharvest costs				10.27
Mow, rake, bale	Bale	105	.21	22.05
Haul	Bale	105	.09	9.45
Total harvesting costs				31.50
Annual interest on capital	Dol.	5.51	.06	.33
Annual charge for establishing (assume 4-year stand)				5.66
Annual interest on establishing costs	Dol.			.68
Total specified costs				48.44
Returns above variable inputs				55.54
Hourly labor				.53
Returns above variable inputs and labor				55.01

Exhibit 9C. - Alfalfa: Estimated annual "adjusted normalized" costs and returns per acre, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	2.0	29.71	59.42
Variable inputs:				
Fertilizer, N.P.K.	Lb.	0-100-0	.12-.10-.05	10.00
Power	Hr.	7	1.28	8.96
Bailer operation (2 times over)	Hr.	3	.50	1.50
Other machinery	Hr.	3	.44	1.32
Bale ties	Ton	2.0	.55	1.10
Haul	Bale	64	.09	5.76
Annual interest on capital	Dol.	10.74	.06	.64
Annual charge for establishing (assume 4-year stand)				10.08
Annual interest on establishing costs	Dol.			1.39
Total specified costs				40.75
Returns above variable inputs				18.67
Hourly labor				7.70
Returns above variable inputs and labor				10.97

Exhibit 9D. - Alfalfa: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	2.3	29.71	68.33
Variable inputs:				
Fertilizer, N.P.K.	Lb.	0-120-0	.12-.10-.05	12.00
Insecticide (Parathion custom)	Application	1	1.75	1.75
Power	Hr.	.38	1.28	.49
Other machinery	Hr.	.35	.81	.28
Mow, rake, bale	Bale	74	.21	15.54
Haul	Bale	74	.09	6.66
Annual interest on capital	Dol.	7.69	.06	.46
Annual charge for establishing (assume 4-year stand)				10.80
Annual interest on establishing costs				1.42
Total specified costs				49.40
Returns above variable inputs				18.93
Hourly labor				.55
Returns above variable inputs and labor				18.38

Exhibit 10A. - Bermuda Pasture: Estimated "adjusted normalized" costs per acre for establishing crop, without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Liming	Ton	1	5.00	5.00
Fertilizer, N.P.K.	Lb.	15-40-40	.12-.10-.05	7.80
Legume seed:				
Vetch	Lb.	10	.13	1.30
Lespedeza	Lb.	5	.14	.70
Contract sprigging	Ac.	1	10.20	10.20
Power	Hr.	1.59	1.28	2.04
Other machinery	Hr.	1.45	.46	.67
Hourly labor	Hr.	1.74	1.25	2.18
Total establishing cost				29.89 1/

1/ ACP payments are not included.

Exhibit 10B. - Bermuda Pasture: Estimated "adjusted normalized" costs per acre for establishing crop, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Liming	Ton	1	5.00	5.00
Fertilizer, N.P.K.	Lb.	20-40-40	.12-.10-.05	8.40
Legume seed:				
Vetch	Lb.	10	.13	1.30
Lespedeza	Lb.	5	.14	.70
Contract sprigging	Ac.	1	10.20	10.20
Power	Hr.	1.59	1.28	2.04
Other machinery	Hr.	1.45	.46	.67
Hourly labor	Hr.	1.74	1.25	2.18
Total establishing costs				30.49 1/

1/ ACP payments are not included.

Exhibit 10C. - Bermuda Pasture: Estimated annual "adjusted normalized" costs per acre for establishing crop, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Liming	Ton	2	5.00	10.00
Fertilizer, N.P.K.	Lb.	20-50-50	.12-.10-.05	9.90
Legume seed:				
Vetch	Lb.	10	.13	1.30
Lespedeza	Lb.	5	.14	.70
Power	Hr.	1.59	1.28	2.04
Other machinery	Hr.	1.45	.46	.67
Contract sprigging (sprigs furnished)	Ac.	1	10.20	10.20
Hourly labor	Hr.	1.74	1.25	2.18
Total establishing cost				36.99 1/

1/ ACP payments are not included.

Exhibit 10D. - Bermuda Pasture: Estimated "adjusted normalized" costs per acre for establishing crop, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Variable inputs:				
Liming	Ton	1	5.00	5.00
Fertilizer, N.P.K.	Lb.	20-40-40	.12-.10-.05	8.40
Legume seed:				
Vetch	Lb.	10	.13	1.30
Lespedeza	Lb.	5	.14	.70
Contract sprigging	Ac.	1	10.20	10.20
Power	Hr.	1.59	1.28	2.04
Other machinery	Hr.	1.45	.46	.67
Hourly labor	Hr.	1.74	1.25	2.18
Total establishing costs				30.49 1/

1/ ACP payments are not included.

Exhibit 11A. - Bermuda Pasture: Estimated "adjusted normalized" costs and returns per acre for maintaining pasture, without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grazing	AUM	4.0, or 40# beef / AUM	.18	28.80
Variable inputs:				
Fertilizer, N.P.K.	Lb.	10-20-20	.12-.10-.05	4.20
Legume seed:				
Lespedeza	Lb.	5	.14	.70
Vetch	Lb.	10	.13	1.30
Power	Hr.	.55	1.28	.70
Other machinery	Hr.	.51	.71	.36
Annual interest on capital	Dol.	7.26	.06	.44
Annual charge for establishing (10-year)				2.99
Interest on establishing cost	Dol.	14.94	.06	.90
Total variable inputs				11.59 1/
Returns above variable inputs				17.21
Hourly labor				.76
Returns above variable inputs and labor				16.45

1/ ACP payments not included.

Exhibit 11B. - Bermuda Pasture: Estimated "adjusted normalized" costs and returns per acre for maintaining pasture, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
	AUM	5.1, or 40#	.18 lb.	36.72
ble inputs:				
ertilizer, N.P.K.	Lb.	60-20-10	.12-.10-.05	9.70
Legume seed:				
Lespedeza	Lb.	5	.14	.70
Vetch	Lb.	10	.13	1.30
Power	Hr.	.7	1.28	.89
Other machinery	Hr.	.6	.71	.43
Annual interest on capital	Dol.	13.02	.06	.78
Annual charge for establishing (10-year)				3.05
Interest on establishing capital	Dol.	15.23	.06	.91
Total variable inputs				17.76 1/
Returns above variable inputs				18.96
Hourly labor				1.24
Returns above variable inputs and labor				17.72

1/ ACP payments are not included.

Exhibit 11C. - Bermuda Pasture: Estimated annual "adjusted normalized" costs and returns per acre for maintaining pasture, without drainage and flood prevention improvements, upland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grazing	AUM	1.8, or 40# beef / AUM	.18 lb.	12.96
Variable inputs:				
Fertilizer, N.P.K.	Lb.	10-20-20	.12-.10-.05	4.20
Legume seed				
Vetch (3 times in 10 years)	Lb.	10	.13	.39
Lespedeza (3 times in 10 years)	Lb.	5	.14	.21
Power	Hr.	.55	1.28	.71
Other machinery	Hr.	.51	.76	.39
Annual interest on capital	Dol.	9.80	.06	.59
Annual charge for establishing (assume 10 years)				3.70
Interest on establishing costs	Dol.	18.17	.06	1.09
Total variable inputs				11.28 1/
Returns above variable inputs				1.68
Hourly labor				.76
Returns above variable inputs and labor				.92

1/ ACP payments are not included.

Exhibit 11D. - Bermuda Pasture: Estimated annual "adjusted normalized" costs and returns per acre for maintaining pasture, with drainage and flood prevention improvements, upland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Grazing	AUM	2.4, or 40# beef/AUM	.18 lb.	17.28
Variable inputs:				
Fertilizer, N.P.K.	Lb.	20-40-20	.12-.10-.05	7.40
Legume seed				
Vetch (3 times in 10 years)	Lb.	10	.13	.39
Lespedeza (3 times in 10 years)	Lb.	5	.14	.21
Power	Hr.	.7	1.28	.89
Other machinery	Hr.	.6	.71	.43
Annual interest on capital	Dol.	9.32	.06	.56
Annual charge for establishing (assume 10 years)	Dol.			3.05
Interest on establishing capital	Dol.	15.33	.06	.91
Total variable inputs				13.84[1]/
Returns above variable inputs				3.44
Hourly labor				1.24
Returns above variable inputs and labor				2.20

1/ACP payments are not included.

Exhibit 12A. - Services Lespedeza: Estimated annual "adjusted normalized" costs and returns per acre without drainage and flood prevention improvements, bottomland soils, good management, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	1-1/2	23.76	35.64
Costs:				
Annual, amortized over 10 years				9.67
Variable, including cutting, raking, baling, and storing (custom)	Ton	1-1/2	9.20	13.80
Total specified costs				23.47
Returns above annual and variable costs				12.17

Exhibit 12B. - Services Lespedeza: Estimated annual "adjusted normalized" costs and returns per acre, with drainage and flood prevention improvements, bottomland soils, advanced technology, Red River Basin Study Area

Item	Unit	Quantity	Price	Amount
			Dollars	Dollars
Production:				
Hay	Ton	3	23.76	71.28
Costs:				
Annual, amortized over 10 years				12.09
Variable, including cutting, raking, baling, and storing (custom)	Ton	3	9.20	27.60
Total specified costs				39.69
Returns above annual and variable costs				31.59

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Barkman Creek												
Texas												
86	0	393	90	483	0	393	90	483	0	0	0	0
131	2,761	875	4,555	8,191	0	0	0	0	2,761	875	4,555	8,191
133	865	519	9,547	10,931	0	0	8,156	8,156	865	519	1,391	2,775
Total	3,626	1,787	14,192	19,605	0	393	8,246	8,639	3,626	1,394	5,946	10,966
Bayou Jean de Jean												
Louisiana												
131	175	510	1,855	2,540	0	0	1,270	1,270	175	510	585	1,270
133	13	14	14,779	14,806	13	14	14,779	14,806	0	0	0	0
Total	185	524	16,634	17,346	13	14	16,049	16,076	175	510	585	1,270
Bayou Pierre												
Louisiana												
131	16,573	30,131	46,699	93,403	0	0	4,670	4,670	16,573	30,131	42,029	88,733
133	1,117	22,816	118,568	142,501	1,117	22,816	118,568	142,501	0	0	0	0
Total	17,690	52,947	165,267	235,904	1,117	22,816	123,238	147,171	16,573	30,131	42,029	88,733
Bayou Rapides												
Louisiana												
131	4,430	10,520	7,800	22,750	0	0	682	682	4,430	10,520	7,118	22,068
133	0	0	1,000	1,000	0	0	1,000	1,000	0	0	0	0
Total	4,430	10,520	8,800	23,750	0	0	1,682	1,682	4,430	10,520	7,118	22,068
Bayou Rigolette												
Louisiana												
131	2,663	5,555	19,278	27,496	0	0	5,400	5,400	2,663	5,555	13,878	22,096
133	0	694	28,326	29,020	0	694	28,326	29,020	0	0	0	0
Total	2,663	6,249	47,604	56,516	0	694	33,726	34,420	2,663	5,555	13,878	22,096

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Black and Saline Lakes												
Louisiana												
131	715	6,521	7,598	14,834	0	0	742	742	715	6,521	6,856	14,092
133	521	7,643	165,026	173,190	521	7,643	165,026	173,190	0	0	0	0
Total	1,236	14,164	172,624	188,024	521	7,643	165,768	173,932	715	6,521	6,856	14,092
Blue River												
Oklahoma												
131	493	0	0	493	0	0	0	0	493	0	0	493
84 & 84a	341	1,519	341	2,201	341	1,519	341	2,201	0	0	0	0
133	0	39	1,624	1,663	0	39	1,624	1,663	0	0	0	0
85	84	680	8,784	9,548	84	680	8,784	9,548	0	0	0	0
Total	918	2,238	10,749	13,905	425	2,238	10,749	13,412	493	0	0	493
Boggy Creek												
Oklahoma												
131	6,742	0	6,565	13,307	0	0	265	265	6,742	0	6,300	13,042
112	0	0	47,231	47,231	0	0	47,231	47,231	0	0	0	0
84 & 84a	0	0	370	370	0	0	370	370	0	0	0	0
133	175	1,522	31,481	33,178	175	1,522	31,481	33,178	0	0	0	0
85	0	0	10,675	10,675	0	0	10,675	10,675	0	0	0	0
119	2,506	2,447	5,984	10,937	2,506	2,447	5,984	10,937	0	0	0	0
Total	9,423	3,969	102,306	115,698	2,681	3,969	96,006	102,656	6,742	0	6,300	13,042
Bois d'Arc Creek												
Arkansas												
86	561	1,564	2,807	4,932	0	0	2,120	2,120	561	1,564	687	2,812
131	0	0	6,018	6,018	0	0	301	301	0	0	5,717	5,717
133	224	2,285	22,850	25,359	0	0	19,758	19,758	224	2,285	3,092	5,601
Total	785	3,849	31,675	36,309	0	0	22,179	22,179	785	3,849	9,496	14,130

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Cane River												
Louisiana												
131	324	9,034	53,783	63,141	0	0	9,470	9,470	324	9,034	44,313	53,671
133	336	1,213	56,849	58,398	336	1,213	56,849	58,398	0	0	0	0
Total	660	10,247	110,632	121,539	336	1,213	66,319	67,868	324	9,034	44,313	53,671
Chatlin Lake and Associated Area												
Louisiana												
131	12,464	25,924	225,157	263,545	0	0	5,270	5,270	12,464	25,924	219,887	258,275
134	3,552	9,032	5,996	18,580	0	902	3,598	4,500	3,552	8,130	2,398	14,080
Total	16,016	34,956	231,153	282,125	0	902	8,868	9,770	16,016	34,054	222,285	272,355
Cypress Creek												
Arkansas												
133	69	941	8,959	9,969	69	941	8,959	9,969	0	0	0	0
Subtotal	69	941	8,959	9,969	69	941	8,959	9,969	0	0	0	0
Louisiana												
131	16,074	6,395	7,622	30,091	0	0	1,500	1,500	16,074	6,395	6,122	28,591
133	313	15,424	47,957	63,694	313	15,424	47,957	63,694	0	0	0	0
Subtotal	16,387	21,819	55,579	93,785	313	15,424	49,457	65,194	16,074	6,395	6,122	28,591
Texas												
133	19,797	64,261	272,547	356,605	19,485	55,254	263,702	338,441	312	9,007	8,845	18,164
Subtotal	19,797	64,261	272,547	356,605	19,485	55,254	263,702	338,441	312	9,007	8,845	18,164
Total	36,253	87,021	337,085	460,359	19,867	71,619	322,118	413,604	16,386	15,402	14,967	46,755
Kiamichi River												
Oklahoma												
131	2,809	906	4,530	8,245	0	0	165	165	2,809	906	4,365	8,080
133	0	8,866	24,083	32,949	0	8,866	24,083	32,949	0	0	0	0
85	0	879	5,871	6,750	0	879	5,871	6,750	0	0	0	0
119	0	13,873	40,642	54,515	0	13,873	40,642	54,515	0	0	0	0
Total	2,809	24,524	75,126	102,459	0	23,618	70,761	94,379	2,809	906	4,365	8,080

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Little River												
Arkansas												
86	3,309	3,623	1,763	8,695	0	0	0	0	3,309	3,623	1,763	8,695
131	229	2,091	30,488	32,808	0	0	3,281	3,281	229	2,091	27,207	29,527
133	3,564	21,621	185,287	210,472	2,851	19,459	183,435	205,745	713	2,162	1,852	4,727
119	0	804	23,597	24,401	0	804	23,597	24,401	0	0	0	0
Subtotal	7,102	28,139	241,135	276,376	2,851	20,263	210,313	233,427	4,251	7,876	30,822	42,949
Oklahoma												
86	542	344	114	1,000	0	0	0	0	542	344	114	1,000
133	0	4,130	17,690	21,820	0	2,685	17,135	19,820	0	1,445	555	2,000
85	0	0	7,407	7,407	0	0	7,407	7,407	0	0	0	0
119	0	3,243	32,070	35,313	0	3,243	32,070	35,313	0	0	0	0
Subtotal	542	7,717	57,281	65,540	0	5,928	56,612	62,540	542	1,789	669	3,000
Total	7,644	35,856	298,416	341,916	2,851	26,191	266,925	295,967	4,793	9,665	31,491	45,949
Loggy Bayou												
Arkansas												
133	2,392	9,123	299,091	310,606	2,392	9,123	299,091	310,606	0	0	0	0
Subtotal	2,392	9,123	299,091	310,606	2,392	9,123	299,091	310,606	0	0	0	0
Louisiana												
131	27,869	11,159	19,862	58,890	0	0	2,355	2,355	27,869	11,159	17,507	56,535
133	383	15,256	197,447	213,086	383	15,256	197,447	213,086	0	0	0	0
Subtotal	28,252	26,415	217,309	271,976	383	15,256	199,802	215,441	27,869	11,159	17,507	56,535
Total	30,644	35,538	516,400	582,582	2,775	24,379	498,893	526,047	27,869	11,159	17,507	56,535
Maniece Bayou												
Arkansas												
131	1,892	7,442	12,666	22,000	0	0	440	440	1,892	7,442	12,226	21,560
133	782	793	7,995	9,570	782	793	7,995	9,570	0	0	0	0
Total	2,674	8,235	20,661	31,570	782	793	8,435	10,010	1,892	7,442	12,226	21,560

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State, and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
McKinney Bayou												
Arkansas												
131	4,987	1,931	55,142	62,060	0	0	1,240	1,240	4,987	1,931	53,902	60,820
133	2,860	3,552	11,298	17,710	2,145	3,197	10,168	15,510	715	355	1,130	2,200
Subtotal	7,847	5,483	66,440	79,770	2,145	3,197	11,408	16,750	5,702	2,286	55,032	63,020
Texas												
131	1,828	375	3,397	5,600	0	0	0	0	1,828	375	3,397	5,600
133	142	85	1,562	1,789	0	0	1,326	1,326	142	85	236	463
Subtotal	1,970	460	4,959	7,389	0	0	1,326	1,326	1,970	460	3,633	6,063
Total	9,817	5,943	71,399	87,159	2,145	3,197	12,734	18,076	7,672	2,746	58,665	69,083
Intervening Areas - Arkansas and Oklahoma												
Arkansas												
86	1,676	0	220	1,896	0	0	0	0	1,676	0	220	1,896
131	6,578	6,199	16,248	29,025	0	0	1,450	1,450	6,578	6,199	14,798	27,575
133	0	0	12,632	12,632	0	0	12,632	12,632	0	0	0	0
Subtotal	8,254	6,199	29,100	43,553	0	0	14,082	14,082	8,254	6,199	15,018	29,471
Oklahoma												
131	13,338	29,430	23,140	65,908	0	0	3,295	3,295	13,338	29,430	19,845	62,613
133	0	7,037	17,688	24,725	0	5,982	17,508	23,490	0	1,055	180	1,235
85	106	915	15,467	16,488	106	915	15,467	16,488	0	0	0	0
Subtotal	13,444	37,382	56,295	107,121	106	6,897	36,270	43,273	13,338	30,485	20,025	63,848
Total	21,698	43,581	85,395	150,674	106	6,897	50,352	57,355	21,592	36,684	35,043	93,319
Intervening Areas - Texas												
Texas												
86	56,891	15,814	29,461	102,166	48,142	9,194	24,238	81,574	8,749	6,620	5,223	20,592
131	28,335	11,679	45,839	85,853	0	0	0	0	28,335	11,679	45,839	85,853
133	10,086	7,487	151,812	169,385	0	0	126,365	126,365	10,086	7,487	25,447	43,020
Total	95,312	34,980	227,112	357,404	48,142	9,194	150,603	207,939	47,170	25,786	76,509	149,465

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State, and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Nantachie Creek												
Louisiana												
133	0	325	10,055	10,380	0	325	10,055	10,380	0	0	0	0
Total	0	325	10,055	10,380	0	325	10,055	10,380	0	0	0	0
Posten Bayou												
Arkansas												
131	8,491	2,481	6,616	17,588	0	0	350	350	8,491	2,481	6,266	17,238
133	190	797	5,499	6,486	190	797	5,499	6,486	0	0	0	0
Subtotal	8,681	3,278	12,115	24,074	190	797	5,849	6,836	8,491	2,481	6,266	17,238
Louisiana												
131	1,918	641	2,709	5,268	0	0	526	526	1,918	641	2,183	4,742
133	0	203	1,138	1,341	0	203	1,138	1,341	0	0	0	0
Subtotal	1,918	844	3,847	6,609	0	203	1,664	1,867	1,918	641	2,183	4,742
Total	10,599	4,122	15,962	30,683	190	1,000	7,513	8,703	10,409	3,122	8,449	21,980
Red River Backwater Area												
Louisiana												
131	9,219	16,828	348,983	375,030	0	2,000	279,275	281,275	9,219	14,828	69,708	93,755
133	0	16	1,170	1,186	0	16	1,170	1,186	0	0	0	0
134	1,630	2,803	13,114	17,547	0	0	3,279	3,279	1,630	2,803	9,835	14,268
Total	10,849	19,647	363,267	393,763	0	2,016	283,724	285,740	10,849	17,631	79,543	108,023
Red River Main Stem												
Louisiana												
131	4,295	16,107	43,510	63,912	0	1,000	30,956	31,956	4,295	15,107	12,554	31,956
133	129	2,649	27,623	30,401	129	2,649	27,623	30,401	0	0	0	0
134	1,332	1,772	997	4,101	0	0	0	0	1,332	1,772	997	4,101
Total	5,756	20,528	72,130	98,414	129	3,649	58,579	62,357	5,627	16,879	13,551	36,057

EXHIBIT 13 - LAND DRAINAGE AND FLOOD PREVENTION FEASIBILITY BY LAND USE, TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA (cont'd)

Red River Basin Study Area, 1962

Tributary Basin, State, and Land Resource Area	Soils With Inadequate Drainage and Flood Prevention Improvement				Soils Not Feasible for Drainage and Flood Prevention Improvement				Soils Feasible for Drainage and Flood Prevention Improvement			
	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total	Cropland	Pasture	Woodland	Total
	Acres											
Sulphur River												
Arkansas												
131	0	0	17,401	17,401	0	0	8,700	8,700	0	0	8,701	8,701
133	112	1,536	14,661	16,309	112	1,536	14,661	16,309	0	0	0	0
Subtotal	112	1,536	32,062	33,710	112	1,536	23,361	25,009	0	0	8,701	8,701
Texas												
86	104,975	79,819	152,351	337,145	78,179	57,523	140,429	276,131	26,796	22,296	11,922	61,014
133	26,430	49,065	193,785	269,280	22,630	25,605	181,025	229,260	3,800	23,460	12,760	40,020
Subtotal	131,405	128,884	346,136	606,425	100,809	83,128	321,454	505,391	30,596	45,756	24,682	101,034
Total	131,517	130,420	378,198	640,135	100,921	84,664	344,815	530,400	30,596	45,756	33,383	109,735
Grand Total	423,207	592,170	3,382,842	4,398,219	183,001	297,424	2,638,337	3,118,762	240,206	294,746	744,505	1,279,457

EXHIBIT 14 - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL
- 1980 AND LONG-TERM -
BY TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area

Tributary Basin, State, Land Resource Area	Total Group Drainage and Flood Prevention Potential	1980 Project	1980 Non-Project	1980 Total	Long-term Project	Long-term Non-Project	Long-term Total
		(Acres)					
Barkman Creek							
Texas							
131	5,700	5,700	0	5,700	0	0	0
Total	5,700	5,700	0	5,700	0	0	0
Bayou Jean de Jean							
Louisiana	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Bayou Pierre							
Louisiana							
131	15,500	0	7,800	7,800	2,500	5,200	7,700
Total	15,500	0	7,800	7,800	2,500	5,200	7,700
Bayou Rapides							
Louisiana							
131	21,700	0	13,000	13,000	0	8,700	8,700
Total	21,700	0	13,000	13,000	0	8,700	8,700
Bayou Rigolette							
Louisiana							
131	15,000	15,000	0	15,000	0	0	0
Total	15,000	15,000	0	15,000	0	0	0
Black and Saline Lakes							
Louisiana	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Blue River							
Oklahoma							
131	500	0	500	500	0	0	0
Total	500	0	500	500	0	0	0
Boggy Creek							
Oklahoma							
131	1,000	0	600	600	0	400	400
Total	1,000	0	600	600	0	400	400

EXHIBIT 14 - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL (Cont'd)
- 1980 AND LONG-TERM -
BY TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area

Tributary Basin, State, Land Resource Area	Total Group Drainage and Flood Prevention Potential	1980 Project	1980 Non-Project	1980 Total	Long-term Project	Long-term Non-Project	Long-term Total
	(Acres)						
Bois d'Arc Creek							
Arkansas							
131	4,000	0	0	0	4,000	0	4,000
Total	4,000	0	0	0	4,000	0	4,000
Cane River							
Louisiana							
131	7,800	0	4,700	4,700	0	3,100	3,100
Total	7,800	0	4,700	4,700	0	3,100	3,100
Chatlin Lake and Associated Area							
Louisiana							
131	247,000	237,000	6,000	243,000	0	4,000	4,000
134	2,000	0	1,200	1,200	0	800	800
Total	249,000	237,000	7,200	244,200	0	4,800	4,800
Cypress Creek							
Arkansas	0	0	0	0	0	0	0
Louisiana	0	0	0	0	0	0	0
Texas							
133	7,400	0	4,400	4,400	0	3,000	3,000
Subtotal	7,400	0	4,400	4,400	0	3,000	3,000
Total	7,400	0	4,400	4,400	0	3,000	3,000
Kiamichi River							
Oklahoma							
131	5,400	5,400	0	5,400	0	0	0
Total	5,400	5,400	0	5,400	0	0	0
Little River							
Arkansas							
131	3,000	0	0	0	3,000	0	3,000
Subtotal	3,000	0	0	0	3,000	0	3,000
Oklahoma	0	0	0	0	0	0	0
Total	3,000	0	0	0	3,000	0	3,000

EXHIBIT 14 - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL (Cont'd)
- 1980 AND LONG-TERM -
BY TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area

Tributary Basin, State, Land Resource Area	Total Group Drainage and Flood Prevention Potential	1980			Long-term		
		Project	Non-Project	Total	Project	Non-Project	Total
	(Acres)						
Loggy Bayou							
Arkansas	0	0	0	0	0	0	0
Louisiana							
131	51,000	51,000	0	51,000	0	0	0
Subtotal	51,000	51,000	0	51,000	0	0	0
Total	51,000	51,000	0	51,000	0	0	0
Maniece Bayou							
Arkansas							
131	21,600	21,600	0	21,600	0	0	0
Total	21,600	21,600	0	21,600	0	0	0
McKinney Bayou							
Arkansas							
131	60,800	60,800	0	60,800	0	0	0
Subtotal	60,800	60,800	0	60,800	0	0	0
Texas							
131	4,800	2,400	1,400	3,800	0	1,000	1,000
Subtotal	4,800	2,400	1,400	3,800	0	1,000	1,000
Total	65,600	63,200	1,400	64,600	0	1,000	1,000
Intervening Areas - Arkansas and Oklahoma							
Arkansas							
131	20,400	8,700	7,000	15,700	0	4,700	4,700
Subtotal	20,400	8,700	7,000	15,700	0	4,700	4,700
Oklahoma							
131	58,800	52,900	3,500	56,400	0	2,400	2,400
Subtotal	58,800	52,900	3,500	56,400	0	2,400	2,400
Total	79,200	61,600	10,500	72,100	0	7,100	7,100
Intervening Areas - Texas							
Texas							
86	6,800	0	4,100	4,100	0	2,700	2,700
131	45,100	11,100	14,500	25,600	9,800	9,700	19,500
133	22,800	0	13,700	13,700	0	9,100	9,100
Total	74,700	11,100	32,300	43,400	9,800	21,500	31,300

EXHIBIT 14 - GROUP DRAINAGE AND FLOOD PREVENTION DEVELOPMENT POTENTIAL (Cont'd)
- 1980 AND LONG-TERM -
BY TRIBUTARY BASIN, STATE, AND LAND RESOURCE AREA

Red River Basin Study Area

Tributary Basin, State, Land Resource Area	Total Group Drainage and Flood Prevention Potential	1980			Long-term		
		Project	Non-Project	Total	Project	Non-Project	Total
	(Acres)						
Nantachie Creek							
Louisiana	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Posten Bayou							
Arkansas							
131	17,200	17,200	0	17,200	0	0	0
Subtotal	17,200	17,200	0	17,200	0	0	0
Louisiana							
131	4,700	0	0	0	4,700	0	4,700
Subtotal	4,700	0	0	0	4,700	0	4,700
Total	21,900	17,200	0	17,200	4,700	0	4,700
Red River Backwater Area							
Louisiana							
131	92,500	72,500	12,000	84,500	0	8,000	8,000
Total	92,500	72,500	12,000	84,500	0	8,000	8,000
Red River Main Stem							
Louisiana							
131	11,000	11,000	0	11,000	0	0	0
Total	11,000	11,000	0	11,000	0	0	0
Sulphur River							
Arkansas	0	0	0	0	0	0	0
Texas							
86	42,800	0	25,700	25,700	0	17,100	17,100
133	11,000	0	6,600	6,600	0	4,400	4,400
Subtotal	53,800	0	32,300	32,300	0	21,500	21,500
Total	53,800	0	32,300	32,300	0	21,500	21,500
Grand Total	807,300	572,300	126,700	699,000	24,000	84,300	108,300